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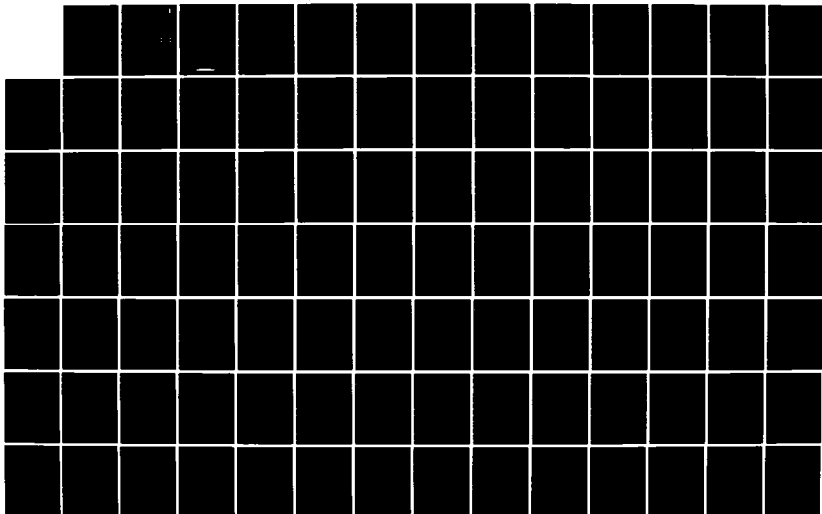
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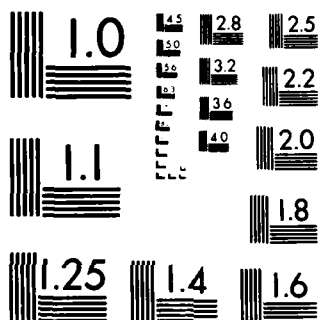
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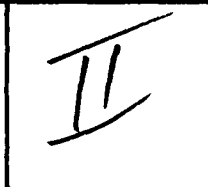


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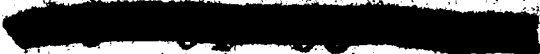
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OF THE JOINT LOGISTICS-OVER-THE-SHORE
(LOTS) TEST AND EVALUATION PROGRAM

30 JANUARY 1977

PREPARED UNDER
CONTRACT NUMBER MDA-903-75-C-0016
FOR THE OFFICE OF THE SECRETARY OF DEFENSE
DEPUTY DIRECTOR (TEST AND EVALUATION)
OFFICE OF THE DIRECTOR, DEFENSE RESEARCH
AND ENGINEERING
WASHINGTON, D.C. 23010



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is a draft report on the design of a joint Logistics-Over-The-Shore (LOTS) operational test to be conducted in the August-September 1977, time frame. The report sets forth the purpose and objectives of the joint LOTS test, provides guidelines and parameters for its conduct, and outlines an analysis plan and data collection requirements. The report was prepared to provide detailed guidance to Service participants in the preparation of draft test plans and will be followed by a final design in March, 1977, (continued)		

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after Service comments have been received and reviewed.

This report expands upon a LOTS Test Definition and Feasibility Study accomplished for the Deputy Director (Test and Evaluation), Office of the Director for Defense Research and Engineering, completed in FY 1975. That study outlined a test to evaluate the Services capability to conduct LOTS operations, including deployment, throughput, and the interface with distribution systems. At that time the need was recognized for the conduct of a series of preliminary field tests to demonstrate the feasibility of deploying selected LOTS heavy and outsized equipment aboard representative merchant ships and to provide data for refinement of the LOTS main test. The results of these tests, as applicable, have been incorporated in the test design. The report also includes a summary of the interim results of the LOTS simulation model used to validate the main test concept and refine resource requirements.

A multi-scenario setting describes the environment and operational parameters for each phase of the LOTS test. The test design concept calls for around-the-clock operations for about 3 weeks, during which time the majority of the cargo throughput will be containerized. The test cargo is provided by: a non-self-sustaining containership loaded with 600 weighted containers (discharged by a crane-on-deck and a temporary container discharge facility), a LASH ship with eight LASH barges, and a heavy-lift breakbulk ship with 600 short tons of palletized cargo and 300 drums of simulated POL products. The heavy-lift breakbulk ship and the LASH vessel will also embark selected LOTS heavy and outsized items as part of the deployment evaluation. In addition to the 600 containers the containership will embark 8 x 8 x 20 shelters, a truck tractor and trailer. Containers will be backloaded periodically in order to support throughput requirements, first in a bare beach environment, second in an amphibious operation with an improved and secure beach, and finally, utilizing all available facilities in an improved beach operated by the joint Services.

ABSTRACT

This is a draft report on the design of a joint Logistics-Over-The-Shore (LOTS) operational test to be conducted in the August-September, 1977, time frame. The report sets forth the purpose and objectives of the joint LOTS test, provides guidelines and parameters for its conduct, and outlines an analysis plan and data collection requirements. The report was prepared to provide detailed guidance to Service participants in the preparation of draft test plans and will be followed by a final design in March, 1977, after Service comments have been received and reviewed.

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I. INTRODUCTION

GENERAL

In 1973 the Deputy Director (Test and Evaluation), Office of the Director, Defense Research and Engineering, requested the Services to submit nominations of projects suitable for joint test and evaluation in the FY 1975-77 time period. Among those nominated by the Army was a Logistics-Over-The-Shore (LOTS) operational test, since the LOTS problem was of increasing concern. This concern was due to trends in ocean shipping to containerships and a military capability to deploy and handle containers in a LOTS operational environment which had not been fully tested.

Early in 1975, the Deputy Director (Test and Evaluation) approved a feasibility and test definition study for a joint LOTS operational test prepared under contract with ORI.¹ The study outlined the general parameters of a joint LOTS test and recognized the need for a series of pretests to verify the feasibility of certain equipment deployment and employment options and to minimize the risk of major interruptions or delays in the main test. A follow-on report by ORI provided designs for such preliminary field tests to be conducted in calendar year 1976.²

¹ Operations Research, Inc., Feasibility and Definition of a Joint Logistics-Over-The-Shore (LOTS) Operational Test, ORI Technical Report No. 913, 30 April 1975.

² Operations Research, Inc., Design of Preliminary Field Tests for the Logistics-Over-The-Shore (LOTS) Test and Evaluation Program, ORI Technical Report No. 993, 6 January 1976.

The feasibility and test definition study provided the general concept and framework for the main test. The Joint Test Directorate (JTD) planning staff at this time requires more definitive guidance for preparation of a detailed test plan. This preliminary report on test design was prepared to serve that purpose. A final test design, prepared in coordination with the JTD planning staff, is scheduled for completion by 31 March 1977.

This introductory section restates the purposes and objectives approved in the Feasibility study, outlines the general scope of the main test, defines special terms for a common understanding of the environmental limitations and subsystems to be tested, and addresses those significant test events which were not pretested in 1976 and require special consideration in the ongoing planning of the JTD.

PURPOSE AND OBJECTIVES

The overall purpose of the joint LOTS test is to assess the capabilities of the Services to conduct LOTS operations. The basic test objectives are to provide information that can be used by the Services to:

- Alter or confirm:
 - Operational techniques
 - Planning factors
 - Equipment requirements
- Determine the best force structure for most efficient use of manpower.

The fundamental data and the derived information from the joint LOTS tests are intended to provide the following:

- An overall determination of the capabilities of a LOTS system representative of that which will be available to the Services in the 1977 to early-1980's time frame, specifically its responsiveness, productivity, and reliability.
- Accurate and reliable information on equipment performance when fully integrated into a system structure and stressed in a realistic operational environment.

- A realistic assessment of each LOTS unit's capabilities (generally measured in terms of quantitative throughput) and soundness of its organizational structure, command and control, doctrine and procedures.
- An operational evaluation of Service capabilities to deploy LOTS system elements including the impact of most likely available sealift assets on system cargo discharge concepts and capabilities.
- A determination of the effectiveness of a remote data terminal subsystem of the Standard Port System (SPS) for providing timely documentation for the identification, control, and shipment of cargo transiting the beach complex.
- A basis for the development of LOTS force requirements to meet specified operational tasks in given contingency situations.

Specific test objectives have been submitted by each Service for evaluation in pretests already completed and/or the main test. A consolidated listing (duplications were eliminated through consolidation) has been compiled by the Joint Test Directorate (JTD) and is reproduced in Appendix A. Each of the Service test objectives have been reviewed for appropriateness within the Deputy Director (Test and Evaluation), ODDR&E approved purpose, scope, and objectives of the joint LOTS main test. With the exception of a few Service subobjectives (indicated by an asterisk in the appendix), all of the Service test objectives can be accommodated in the main test design. The Services may separately evaluate "add-on" R&D test items as long as such testing and data collecting do not detract from, delay, or impede the conduct of the main LOTS test.

SCOPE

The joint LOTS main test will be conducted in a multi-scenario setting, reflecting likely non-mobilization and full mobilization situations as defined below and in Appendix B.

Three vessel types are planned for charter: a containership with crane-on-deck (COD) and "live" containerized cargo aboard; a heavy-lift break-bulk ship loaded with selected LOTS equipment items and breakbulk cargo; and a LASH bargeship with barges containing vehicular, palletized, and container exercise cargo, plus deck-stowed selected outsized LOTS equipment.

The main test will be conducted during the August-September 1977 time frame. With allowances for delays due to weather and/or underlapping ship schedules, the exercise is planned to be completed in about 21 days. For the overall schedule of test events see Figure 1.1.

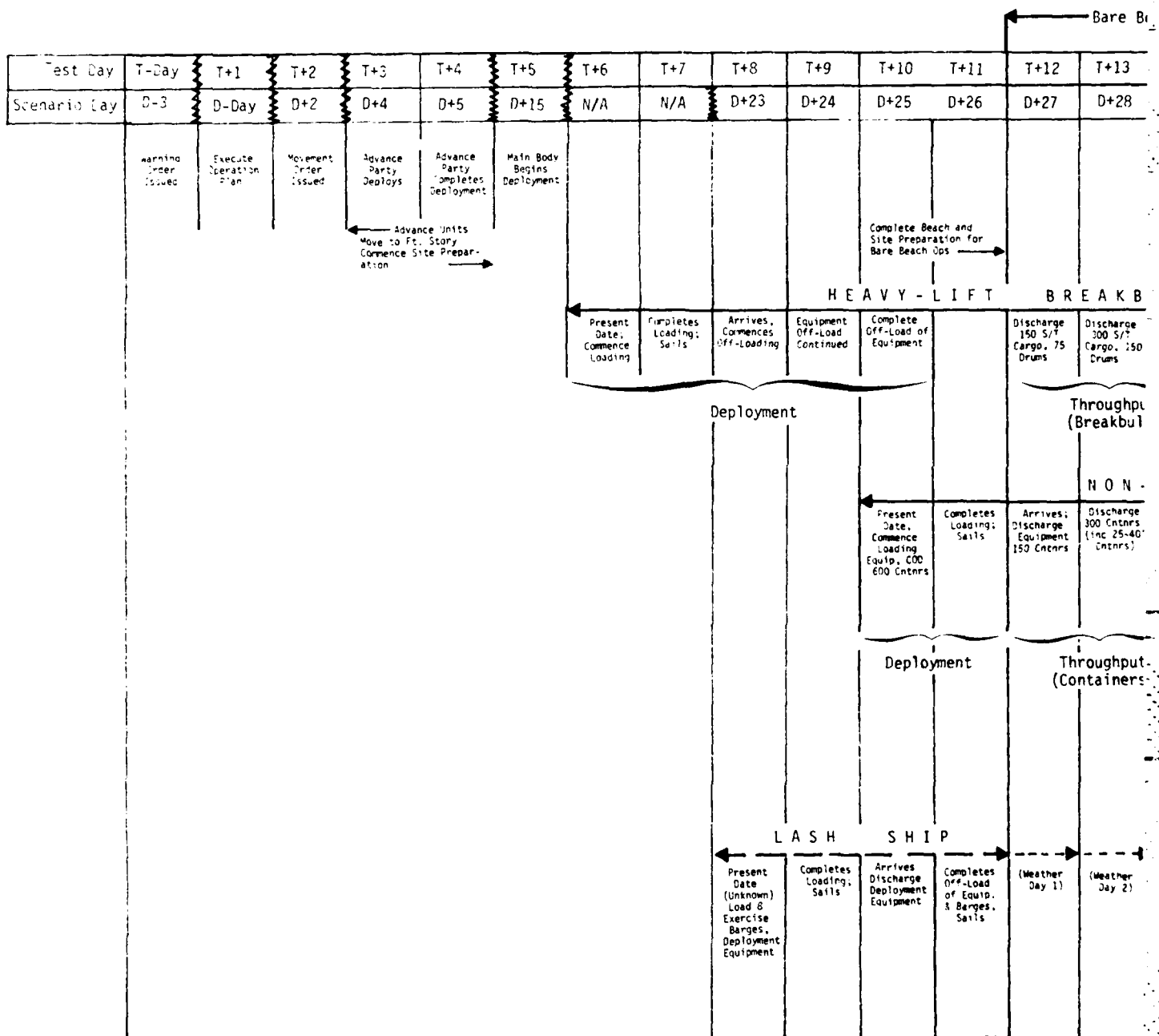
LOTS TEST ENVIRONMENT, SUBSYSTEM DEFINITIONS

For a realistic test and evaluation of Service capabilities to conduct LOTS operations, a three-phased approach with appropriate scenarios was adopted. The first phase represents the worst case: the bare beach capabilities representative of a non-mobilization contingency in an undeveloped area. This situation depicts LOTS operations conducted over a beach facing an open sea which, prior to force arrival, is devoid of piers, jetties, or like structures that could be used to assist the force in the transfer of personnel, equipment and other cargo from ship to shore (hence the term "bare beach"). Site improvements will be limited to the capabilities of the LOTS personnel, tools, and equipment which can be deployed within the time and shipping/aircraft available as specified in this test design. Improvements will be necessary to facilitate movement to and over-the-shore, the emplacement of cargo handling equipment, movement of beach traffic, and establishment of operating units and their command/control elements ashore.

The two phases that follow involve improvements through the erection of off-shore and shoreside container/general cargo transfer facilities which would be available in a mobilization setting. In this test the improved beach phase will include the use of the elevated causeway and the "B" DeLong pier with cranes for transferring cargo. The temporary container discharge facility (TCDF) would also be available during this phase.³ The facilities

³ Note that in the bare beach phase the TCDF is operating as a second "crane-on-deck" in order to have two cranes discharging and backloading containers.

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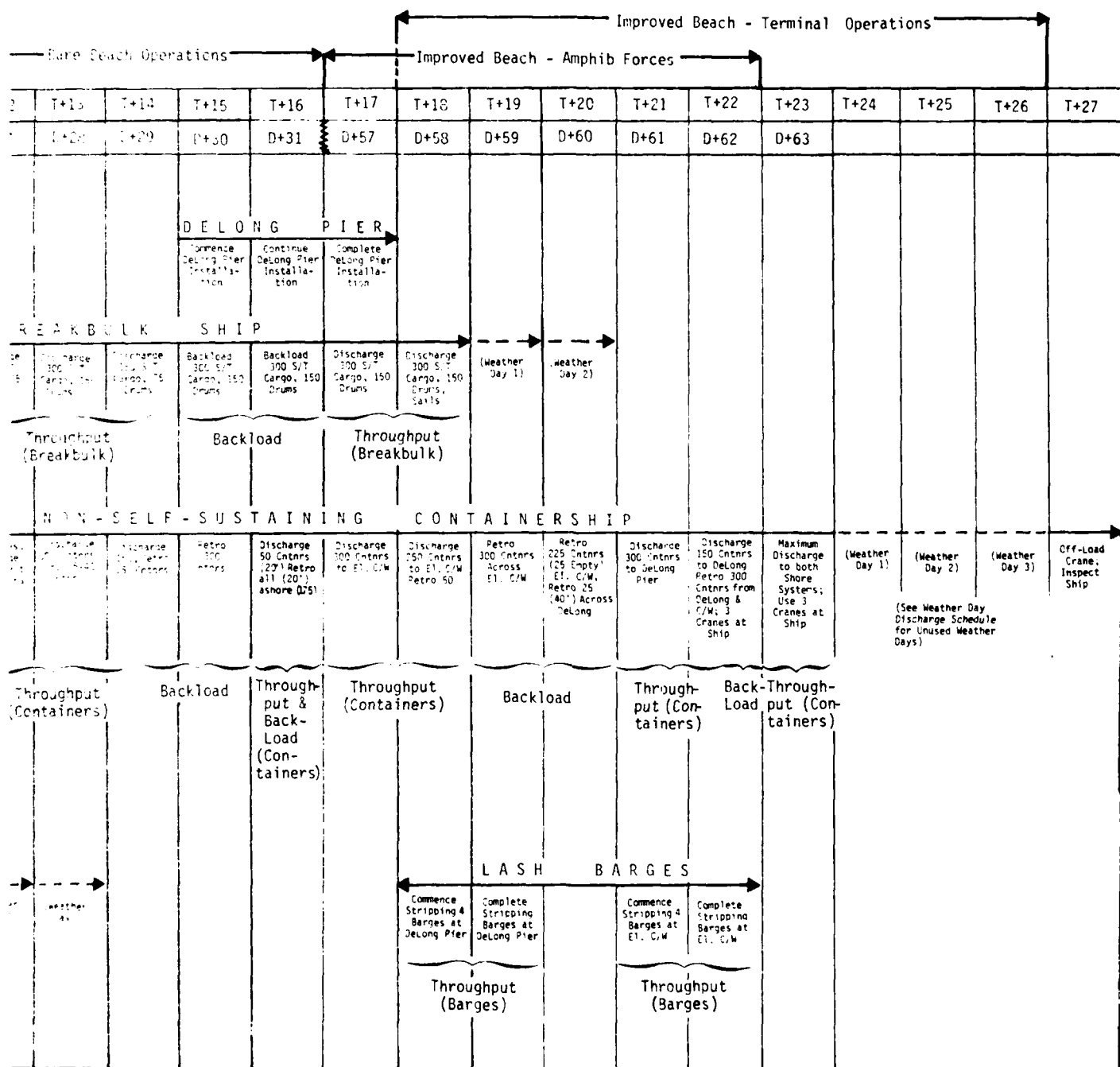


FIGURE 1.1. ILLUSTRATIVE MAIN TEST EVENT SCHEDULE
(Real Test Time and Multi-Scenario Time Phasing)

and equipment to be used in both the bare and improved beach settings are described in detail in Section II under "Description of System Elements to be Tested." General definitions are given here for an understanding of the discussions that follow. Where applicable Service proponency for development is as indicated in parentheses.

- Crane-on-Beach. A container handling crane installed on a platform on the beach. The most rudimentary type consists of a sand ramp, or small jetty of sand or other immediately available materials surfaced with planking over prefabricated timber "mud shoes." The crane transfers containers from lighters (non-amphibians) to vehicles for movement to a cargo marshalling area. An analysis of shoreside unloading difficulties with respect to beach gradient and surf is contained in Appendix C. (Army proponency)
- Crane-on-Deck (COD). A crane working from a set of movable prefabricated platforms placed on the deck of a containership. The concept for actual emergency operations is to employ two sets of equipment, one crane moving down each side of the ship alternately opening and closing hatches and discharging containers to lighters alongside. For the LOTS test only one COD is planned. (Navy proponency)
- Elevated Causeway. Floating causeway sections, with specially installed spud wells, joined together and elevated above the surf on pilings/spuds. A mobile crane is placed on the end section for transferring containers from lighters to vehicles. (Navy proponency)
- Temporary Container Discharge Facility (TCDF). A container handling crane mounted on a floating platform for the transfer of containers from ship to lighters. The test equipment consists of an Army P&H 6250 (300-ton capacity) crane mounted on a DeLong floating pier section. (Army proponency)

- Test (T) Days and Scenario (D) Days.⁴
 - In the schedule of test events contained in Section II, Main Test Design, and summarized in Figure 1.1, T-days are the days in the test design in which specific test events or milestones are scheduled. Beginning with the date a warning order is issued for deployment, T-days extend through all test phases and scenarios and indicate when a major data collection effort is required.⁵
 - D-day is defined as the day the order is given to execute the operations plan. D-days are keyed to the scenario and depict realistic times for deployment of units and their equipment to the objective area.

RESIDUAL PRETEST EVENTS

Pretests were conducted during 1976 testing the feasibility of various equipment deployment options by different vessel types and, to a limited degree, the operating capability of the subsystem elements described and defined above. The following test actions were planned but not carried out to date:

- Deployment of major LOTS equipment items by containership with COD. Test cancelled after engineering studies because the Services lack a current capability and would require a special R&D effort to achieve it. Capabilities of the COD platform with crane, now under development, have not been tested.

⁴ The designation of test days by another reference point such as "X" days as the first day of containership operations off Ft. Story may be used by the JTD planning group for keying test events to the availability of the containership.

⁵ The erection of the elevated causeway, discussed later, is a special case in which data collection will be subject to further refinement once elevated causeway scheduling and training objectives can be more clearly defined. Therefore, no T-day has been established for this event.

- Deployment and operation of the LACV-30 (Ligher Air Cushion Vehicle, 30-ton capacity) in an operational environment. This craft currently is undergoing extensive user acceptance testing. Data derived from these tests will be used for main test planning (average speeds, loading and unloading times, fuel-payload trade offs, etc.). Deployment test lifting will be accomplished prior to the joint LOTS test.
- Test loading of a "B" section De Long pier on a SEABEE barge-ship. Test cancelled due to non-availability of ship for such a lift until litigation over elevator defects is concluded. Data are being compiled for analysis and preparation of a report on the feasibility of this deployment option.
- Deployment and employment of the Army frontloader for handling 20- to 40-ft containers. Delivery is not scheduled before March, 1977. Equipment should be deployment-tested in LOTS training tests scheduled for the Spring-Summer, 1977.
- Due to a lack of Army capability (serviceable assets on hand), the handling of bulk fuel from tanker-to-shore and distribution inland will not be played. No assets are programmed for FY 1977 procurement.⁶

The results of pretests, principally equipment deployment feasibility and timing data, have been incorporated in the main test design outlined in this report and will be considered in the preparation of the operational plans of the JTD.

⁶ Information provided by U.S. Army Quartermaster School project officer, as of December, 1976.

II. MAIN TEST DESIGN

GENERAL

This section provides guidelines for the development of detailed test plans and operation orders by the JTD and participating units. The major topics are arranged in the following sequence:

- Measures of effectiveness (MOE)
- Planning factors
- Deployment
- System elements to be tested

Measures of effectiveness and planning factors are treated first because of their importance in the sequencing and duration of test events. Similarly, the requirement to validate planning factors requires round-the-clock operations in a realistic environment. Deployment describes the parameters within which the units move from home station to the objective area and the constraints on procedures, resources, and facilities before becoming operational. This is followed by a detailed description of LOTS system elements and the conditions under which they will be tested. A brief summary of preliminary LOTS simulation model runs is given in Appendix D as a basis for test planning. Additional simulations will be made as detailed planning progresses and the impacts of proposed changes need to be assessed.

MEASURES OF EFFECTIVENESS (MOE)

The overall effectiveness of a LOTS system is judged on its ability to provide timely and adequate support to combat forces. In order to provide a basis for measurement and analysis, LOTS system capability is normally expressed in terms of daily "throughput." This throughput, generally stated in tons (and/or numbers of containers) per day for dry cargo, is the amount of resupply unloaded from shipping and cleared daily from the beach complex by highway, rail, inland waterways, etc. In view of the sensitivity of LOTS operations to weather conditions, the system must be adaptable to and operate under a fairly wide range of conditions and over time still meet average throughput requirements. Sufficient quantities of supplies must be transhipped to inland supply points not only to sustain daily consumption but also to build up a safety level for accommodating interruptions and losses due to enemy action, storms, and the like. That average daily total requirement becomes the operating objective of the LOTS force.

Note that unlike weapons system effectiveness, where the numbers involved sometimes have self-evident evaluations (such as single shot kill probabilities) there is no norm or standard for throughput support. Comparisons can be made with planning factors where these have been established, but generally the effectiveness of the LOTS operation will have to be judged, not on a comparison basis, but rather on internal evidence, such as the capabilities of making the most effective use of available manpower and equipment.

Deployment MOEs

The ability to deploy a LOTS system, particularly very large and heavy equipment, will be the first major area to be evaluated. Deployment as used herein encompasses all steps necessary to move equipment, personnel, and supplies to an objective area and establish a throughput capability. Thus, deployment measures of effectiveness must take into account the capability to use the most available sealift resources (MSC assets, in this case), the capability to lighter this equipment ashore, the establishment of an unloading system, and the resultant impact on system cargo discharge concepts and capabilities. Deployment will include both simulated air and sea movement, as well as that cargo actually moved by ship. The deployment phase terminates when a throughput capability is established ashore and LOTS operations begin.

Sequentially, the first MOE relates to the ability of the exercise unit to meet deployment schedules (discussed later). Once these schedules are met the exercise of loading selected items will provide the opportunity to ensure that the means and capabilities for loading the extraordinary LOTS equipment items are operable and effective, and ship departure schedules can be met. Once the equipment has been moved to the objective area, the ability and time to lighter this equipment ashore, off-load it from landing craft, and become operationally effective will be important. Time will be one of the most important measures upon which judgment on deployment effectiveness will be based.

Not all MOEs on deployment will be based on data collected in the Test.¹ Table 2.1 contains examples of deployment MOEs.

TABLE 2.1
DEPLOYMENT MEASURES OF EFFECTIVENESS

Test Objective	Measures of Effectiveness
Confirm the capability of terminal service units to meet CONUS load-out times.	Time required to meet deployment requirements for overseas movement and move to appropriate POE's.
Confirm the capability to load selected items of LOTS equipment aboard commercial shipping.	The time required to load each item.
Establish a throughput capability for movement of containers across a bare beach.	Total time required for terminal service units to establish its throughput capability (containers per day).

¹ Operations Research, Inc., Feasibility and Definition of a Joint Logistics-Over-The-Shore (LOTS) Operational Test, 30 April 1975, ORI Technical Report No. 913, page C-3, Appendix C.

Throughput MOEs

Throughput is the net output of the entire LOTS operating system. The most restrictive subsystem capability determines the throughput capability of the entire system. With the resources available the LOTS commander allocates personnel and equipment to balance cargo handling and transport capabilities. Adjustments are made as conditions (types of cargo, environmental conditions, etc.) change in order to maximize throughput.

Planning factors are closely akin to these measures of effectiveness. Already established LOTS system planning factors will be altered or confirmed and new planning factors will be derived from test data accumulated through the execution of this test. (The planning factors to be evaluated in the Main Test are listed in Table 2.4 and discussed later.) Table 2.2 contains examples of throughput MOEs related to specific test objectives.

TABLE 2.2
THROUGHPUT MEASURES OF EFFECTIVENESS

Test Objective	Measures of Effectiveness
Confirm the capability of the USA Trans. Terminal Co. (container) to handle containers (import and combination of import/export).	Numbers of containers sustained throughout per 20-hr day: 1) all import 2) combination import/export.
Determine the container handling capability of specified LOTS subsystems (COD, TCDF, etc.) or equipment items (LACH,* rough terrain forklift, etc.)	Number of containers off-loaded/handled per 20-hr day by each subsystem or equipment item.
* Lightweight Amphibious Container Handler (LACH), a Marine Corps experimental vehicle for handling containers on the beach, in the logistic support area, or other unimproved areas.	

Distribution System

General. Since the exercise area is confined to the limits of Ft. Story, the designated locations of consignees (DSUs, GSUs, etc.) will be relatively close to the marshalling area. Direct delivery of supplies to consignees will be played; therefore the distribution segment being evaluated will include movement from the beach to and through the marshalling area to the consignee. There will also be a requirement for limited unstuffing of containers

for shipments from the marshalling area. The most important area to be evaluated will be Service standards and procedures for identifying, locating, documenting, accounting for, controlling, and forwarding cargo to consignees. Organizational structure, equipment, and manpower utilization as they affect this portion of the distribution system will also be evaluated.

Cargo Distribution Management. The Army Standard Port System (SPS) utilizing automated procedures will be used to provide documentation from a fixed logistical base to a mobile SPS van in the beach area through a communications link. Evaluation will center on system response time and probability of performing essential functions in a LOTS environment. An element of Headquarters, 1st Corps Support Command will provide player support for movement control functions in the exercise. Although this command element will not be evaluated, the response of the LOTS organization to the movement control play (changes in priorities, consignees, etc.) will be.

Distribution System MOEs. The kinds of measures of effectiveness that are expected to be useful in the distribution portion of the LOTS test are deployment times, cargo management and distribution capabilities. Table 2.3 contains examples of specific MOEs.

TABLE 2.3
LOTS DISTRIBUTION SYSTEM MEASURES OF EFFECTIVENESS

Test Objective	Measures of Effectiveness
Verify the technical capabilities and adequacy of field operating procedures to provide all required transportation data and documentation.	Initiating and maintaining records identifying containers and breakbulk cargo and sorting them for appropriate destinations in a timely manner. Documentation capability for all cargo and container movements per day. (All delays in movement of cargo due to faulty or non-available documentation will be recorded.) Percent of errors in documentation: cargo identification including special codes, consignee, mode, date-time of receipt and shipment, etc.
Emergency continuity of operational procedures. ¹	All procedures used to continue SPS operations from temporary disruption to total loss of mobile SPS van.
Deployment and environmental effects on SPS equipment.	Determine any adverse effects of weather (dust, etc.) on operating efficiency of the ADP equipment and communication links.
¹ At a specified time during the exercise the mobile SPS van will be shut down simulating the loss of the equipment due to mechanical failure.	

PLANNING FACTORS

Service unit capabilities for conducting LOTS operations and existing planning factors both need to be validated as most of them were derived from limited exercise experience and estimates. In the analysis of data, inefficiencies, delays, and interruptions normal to actual operations will be taken into account. All decisions concerning non-chargeable time delays will be made on a case by case basis.

Examples of key LOTS planning factors which require quantitative validation in a realistic operational environment are contained in Table 2.4.

TABLE 2.4
KEY LOTS PLANNING FACTORS

Unit/Item Being Tested	Quantitative Factor or Capability to be Validated
Trans Tml Bn Hq	Command and control of tml units
Trans Tml Co. (Container)	300 containers/day discharge or retrograde combined
Trans Tml Co. (Breakbulk)	1,000 S/Tons general cargo/day
Trans Med Boat Co.	1,000 S/Tons per day (number of containers/day to be determined)
Trans Hvy Boat Co.	1,440 S/Tons per day (number of container/day to be determined)
Trans Med Amphib Co.	Number of containers per day (to be determined)
Trans Hvy Amphib Det.	Number of containers per day (to be determined)
Trans LACV Plat (Prov)	240 containers/day (tentative)
USMC Shore Party Det.	300 S/Tons per day or 350 containers/day
Elevated Causeway	Time to erect: 36 hr; 300 containers/day (tentative)

DEPLOYMENT

General

Deployment of LOTS equipment and personnel constitutes one of the major areas of analysis of the LOTS system. Thus, the means for deployment and the requirements to execute movement of LOTS units must be closely detailed. Generally, it is planned that Army units will be deployed via airlift² for personnel and high priority engineer equipment such as dozers and the advanced multipurpose soil stabilization (AMSS) equipment needed to initiate site preparations. Commercial shipping will be used for all other unit equipment. Navy and Marine Corps exercise units will primarily be deployed in assault force shipping (amphibious ships)³ with some equipment and personnel embarked in commercial ships of the assault-follow-on-echelon (AFOE). Details for unit deployments are discussed later.

It will not be necessary to embark all equipment aboard merchant ships, but rather deployment objectives can be satisfied by selectively loading equipment aboard certain ship types for introduction into LOTS scenarios as appropriate. This approach is necessary to limit test duration and facilitate ship employment during the test. The majority of the equipment deployed will be test loaded aboard the heavy-lift breakbulk ship prior to the initiation of bare beach operations.

Heavy-Lift Breakbulk Ship Deployment

Representative items of LOTS equipment will be embarked aboard a Military Sealift Command (MSC) chartered vessel, specifically, a heavy-lift breakbulk ship from the controlled fleet. Subject to vessel schedule and space available, a minimum of one of each type of equipment weighing more than 20 tons will be embarked to ensure that slings, shackles, and other necessary rigging gear are available and usable. The equipment to be loaded, for example, will include (but not be limited to) the following Service equipment: sideloader,

² Movement by air will be simulated.

³ Assault shipping will be simulated, although an amphibious ship is tentatively planned for movement of USMC units from Camp Lejeune, North Carolina, to the objective area.

frontend loader, P&H 9125 crane (tactical configuration), P&H 6250 crane (tactical configuration), LARC-LX, mobile Standard Port System (SPS) van, LACV-30, LCM8, 1646-class LCU, 1466-class LCU, yard tractor and trailer, M52 truck tractor (provided by USMC), M127 modified trailer (provided by USMC), and a 30-ton mobile crane (provided by USMC). Other support equipment may be embarked as directed by the JTD or as requested by the Services, subject to ship space availability. In the event a heavy-lift breakbulk ship is not available, two conventional breakbulk ships with heavy-lift booms of 60-long ton or greater capacities may be substituted.

LASH Ship Deployment

In the event a LASH ship becomes available prior to the containership, the LACV-30 will be test loaded as a deployment item. Independent of ship availability a 3 x 14 causeway warping tug (subject to asset availability), an LCM8 (using its regular lifting sling), a 3 x 15 causeway section, and causeway piling will be loaded. Other Service equipment may be embarked during the 4-day load/off-load charter period, subject to approval of the JTD. The ship will also carry eight exercise barges, four loaded with containers and four loaded with pallets and vehicles.

Although the LASH ship is scheduled to participate in the mobilization phase, ship availability and the critical timing of certain test events necessitate that its scheduling be more flexible. The LASH vessel chartered must be used as it becomes available, otherwise, additional and unnecessary charter costs are incurred by delaying its employment. With a LASH vessel the needed flexibility is possible. The deployment cargo (i.e., deck-stowed items) will be off-loaded and lightered ashore upon arrival off Green Beach, Ft. Story. The eight LASH barges will be moored to a mooring buoy until the mobilization phase when they will be stripped at the assigned improved beach unloading facility.

NSS Containership Deployment

An examination of capabilities to use the NSS containership as an augmentation vessel for deployment proved during the pretest phase that outsized equipment heavier than containers could not be accommodated. However, the capabilities to use the ship for some light equipment items (other than those previously discussed) is possible. Accordingly the test load on the NSS containership should include a truck-tractor and container chassis. In addition, USMC 8 x 8 x 20 shelters will be loaded in container spaces.

Documentation Support

To support deployment analysis the LOTS exercise Joint Task Force (JTF) commander must realistically ensure preparation of all documentation (less ship and aircraft stowage diagrams) necessary for movement of task force personnel, equipment, and unit impedimenta. Complete documentation is considered important enough to merit prohibiting entrance to Ft. Story of all military tactical equipment and organizational property employed in the test unless accompanied by shipping documentation/embarkation data. (Special procedures will be developed for vehicles that arrive inadvertently without proper documentation.)

Once aboard the Ft. Story complex unit equipment should not be permitted to depart until termination of the exercise or unless the item is being "retrograded to CONUS by sealift/airlift." If an item is "retrograded," it is not expected to be returned to service during the remainder of the exercise. Order and ship time would exceed the duration of the exercise. These restrictions appear necessary to ensure that deployment requirements are fully identified, including supply and maintenance support for participating units.

Deployment for Army Bare Beach Operations

To support the bare beach phase of the test (non-mobilization scenario) an advance party will be airlifted to the objective area for site reconnaissance. A limited number of aircraft sorties will be available to also transport high priority units and equipment for initiation of site preparation. This simulated airlift will begin 23 scenario days prior to the commencement of the cargo throughput phase of the exercise. The Army component commander is required to submit unit movement requirements to the Military Traffic Management Command through installation transportation officers. (ORI acting for ODDR&E (T&E) will receive documentation and simulate action of all agencies outside the JTF; in addition, the JTD will act as the area Commander-in-Chief (CINCAREA).) For exercise purposes this requirement should be forwarded not later than 2 May 1977 for sortie approval/allocations.

Follow-on deployment of personnel will be accomplished via airlift commencing D+15, to be completed 72 hours prior to arrival of the first commercial ship. All unit equipment normally deployed in the seatail will be

embarked in this echelon. For the non-mobilization scenario only one ship, a heavy-lift breakbulk ship, will be available for actual seatail deployment. Personnel and cargo not embarked aboard the test ship will be moved via land to Ft. Story where shipping documentation can be checked by exercise control personnel at the Ft. Story gates. If some of this cargo is moved by landing craft or amphibians to Ft. Story, the same documentation and data collection checks must be made at the off-loading point.

Deployment of Amphibious Forces

Participating amphibious units would normally have the majority of their personnel and cargo handling equipment embarked in the assault shipping. Exceptions might be (subject to the amphibious mission) the Navy Cargo Handling and Port (NAVCHAP) Group, certain organizations having heavy equipment and vehicle support and some heavy engineer units. Amphibious assault shipping has the capability to deploy the elevated causeway system, assuming tactical requirements permit--for this scenario it is assumed the elevated causeway was deployed in this manner. The elevated causeway will be erected prior to the arrival of the containership. Navy and Marine Corps personnel and their equipment will be administratively introduced into the LOTS exercise in much the same manner that Army units were "airlifted" to the objective area. Embarkation data will be submitted on all personnel and equipment participating in the exercise.

Improved Beach Operations

This aspect of the LOTS test allows for the introduction of very large LOTS components that have special shipping requirements which are not likely to be met unless there is a national mobilization. No deployment restrictions are placed on the size or type of LOTS support equipment which may be introduced at this time, as long as it can be loaded on some U.S. merchant ship. Because of current litigation between the ship owner and ship builder it probably will not be possible to exercise the SEABEE in the test. However, for exercise purposes, deployment by SEABEE is assumed.

The joint LOTS main test plan commences with the alert of participating units and the assembly of a Joint Task Force command element at Ft. Eustis, Virginia. Units are brought to a high state of readiness and prepare to deploy to aerial and sea Ports-of-Embarkation (POEs) on order.

Seventy-two hours after receipt of the warning order (on D-3), orders are received to execute the operation plan (D-Day). Advance parties of the JTF headquarters and elements of the port construction and other key units depart for the objective area on D+4 and D+5. (Movement by air will be simulated. Advance parties will move by highway to Ft. Story, perform required site selection, and begin establishment of an operating base.)

Ten days later (D+15) the main party begins its deployment by air with minimum essential equipment to assist in preparation of the beach site, routes to and from an assembly area, etc. The deployment will be accomplished in seven echelons to be completed by D+21. Although all such equipment actually will be moved by surface means, each item will be documented indicating full nomenclature, and dimensions and how deployed; e.g., tractor, FTRAC, D7 with dozer blades, 168 in. x 83 in. x 61 in., 36,805 lb, 492.2 cu, deployed by C141 or C5.

Five days after receipt of movement orders (D+7) the simulated JTF seatail echelons depart for loading at water ports of embarkation. The seatail for this test will include LOTS outsized and heavy equipment (discussed above) loaded on the heavy-lift breakbulk ship. The balance of the unit table of organization and equipment (TOE) and accompanying supplies will move by surface means to the operating area. Again, all major equipment items will be documented. Data will be obtained for later compilation of shipping that would have been required to deploy these units. Figure 1.1 (contained in Section I) is a summary of deployment dates.

The advance parties and main bodies—both air and seatail—will deploy early enough during the exercise to ensure that the beach is fully operational before the non-self-sustaining containership is standing offshore. Backward planning from that date is required to meet beach preparation objectives.

Because amphibious units are part of a separate scenario (the above scheduling relates only to bare beach operations) and because Navy units will be conducting unit training at the test site, these deployment schedules will not apply. Marine Corps advance units will be administratively positioned ashore prior to arrival of test vessels on which USMC equipment is embarked.

DESCRIPTION OF SYSTEM ELEMENTS TO BE TESTED

General


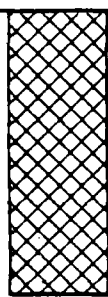
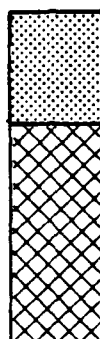
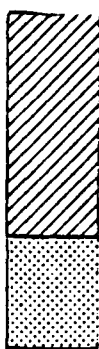
The LOTS main test is broadly designed to support both the common-user type LOTS terminal operations and the related requirements of a Navy/Marine Corps amphibious follow-on operation. Both of these activities involve commercial type ships provided through the Military Sealift Command and, while there are some system equipment and technique differences resulting from specific service requirements,⁴ the fundamental functional elements to perform the LOTS task are practically the same for both. Based on these similarities only, the LOTS test will involve the types of operations depicted in Table 2.5. The assault phase of an amphibious operation is conducted in a high threat environment and is outside the definition of a LOTS operation. Therefore, it will not be played. The amphibious forces follow-on phase depicted in this exercise is not conducted in a high threat environment. It subsequently transitions into a joint Army-Navy operation.


The LOTS Test Feasibility and Definition Study categorized the LOTS system configuration as follows:


- Ships to deploy LOTS system equipment and personnel
- Crane subsystem for ship off-loading
- Lighterage subsystem for ship-to-shore movement


⁴ Reference is primarily to the constraints in the early support phases of amphibious operations necessary as a result of tactical considerations. Service equipment and technique differences also emanate from deployment methodology; specifically, follow-on support for amphibious operations has usually been moved in specially configured ships organic to amphibious forces while the deployment of Army LOTS equipment must employ commercial type ships.

TABLE 2.5
OVERVIEW OF OPERATIONS SCHEDULED FOR THE JOINT LOTS MAIN TEST

	Bare Beach Operations	Improved Beach Operations
Amphibious Assault General Unloading*	 (Not Played)	
Terminal Operations	 (5 Days)	
Amphibious Follow-on		 (4 Days) (2 Days)
Joint Terminal Operations		 (2 Days) (4 Days)
* A tactical support operation involving high threat. Not a LOTS operation and not included in this test.		

 Container and Breakbulk Operations

 Container Operations Only

 LASH Barge Operations

- Shoreside unloading subsystem
- Beach staging and clearance subsystem
- Management and control system.

These system configurations available for testing encompass the areas of deployment, throughput, and shoreside distribution activities. This section primarily addresses the throughput phase and the specific elements of that phase which are to be tested. Because the throughput phase is the most complex, the test has been structured to concentrate its evaluation in this area. In this regard, the effectiveness of each element of the throughput system is primarily meaningful with respect to its relationship to the remainder of the system; that is, the slowest element will limit the throughput rate of the overall system. Thus, a key objective of the test will be to stress elements individually as well as collectively wherever and whenever possible to determine the weakest links and to learn where further improvements and refinements may be required.

For best evaluation results, system elements must operate realistically and in their most efficient manner. Similarly, system elements must mesh smoothly with other components where appropriate. Back-up procedures and equipment (discussed in detail later) must be available when situations arise which threaten to interrupt or actually halt operations.

It is anticipated that the integrated use of different Service assets to support throughput requirements will be both necessary and desirable. The commonality of many items, such as LCUs and LCM8s, helps ensure that sufficient resources are available to conduct the test without interruption in any phase and simplify data management. Service roles and missions within the boundaries of the test will not be evaluated, but Service capabilities and planning factors associated with LOTS equipment and support operations will be. In addition, because of the fundamental similarities of equipment and operational procedures and the structure for data collection and reduction methods, it is anticipated that the results can be extrapolated for use in future Service planning and studies.

Crane Subsystems for Ship Off-Loading

Container unloading will be accomplished using two crane off-loading methods, the crane-on-deck (COD) and the temporary-containership-discharge-facility (TCDF). In LOTS operations the COD method would be employed first, since it would be deployed aboard the containership. Subsequently, the TCDF would be deployed to the objective area, its arrival time subject either to the amount of time necessary to tow it there or the availability of a commercial ship capable of loading and off-loading it. With only one COD and one TCDF available, however, both off-load methods will be evaluated in the LOTS test simultaneously. The analysis of crane component availability will be separately addressed.

Crane-on-Deck. The Crane-on-Deck (COD) option will employ a commercially leased, crawler (tracked) crane. This crane will be used to off-load containers in cells and on the main deck as well as the specified deployment cargo. A crane survey supplied by Naval Sea Systems Command provides a listing of potential sources for crane leasing and information on basic operational capabilities.⁵ The minimum operating radius (with two exceptions⁶) would require a crane of at least 140-ton manufacturer's nominal maximum capacity. The crane operators should be from the Services, even if insurance or contractual arrangements require that a civilian operator is on-hand to assist and/or supervise. The type crane preferred cannot yet be specified without further details regarding the hatch bridging and deck reinforcement kit under development by the Navy.

The capability of the hatch bridging kit to support the heavy loads of some of the larger crane models is unknown. While it may be possible to gain some operational advantages with the greater reach of a larger crane, there may be operational and structural costs associated with the larger crane or a re-designed hatch kit that would be less desirable. Currently these issues are being addressed.

⁵ Naval Sea Systems Command (NAPEC) Naval Weapons Support Center, NAVSEA COD System Crane Survey, dated 1 July 1976.

⁶ Ibid., pages 7 and 8.

To date, none of the Services have had any experience in COD operations other than observations of civilian operators on a 90-ton truck crane during OSDOC II. This is due to the newness of large container cranes in the Service inventory, the non-availability of a hatch bridging and deck reinforcement kit, and the high cost of containerships for military exercises. Early availability of the hatch kit is being sought to permit practice on land in the movement of the crane and the hatch kit on a simulated deck.

Temporary Container Discharge Facility. The second crane subsystem available for containership unloading during the LOTS test is the TCDF, in this case an Army P&H 6250 truck-mounted crane that has been loaded on a "B" DeLong barge. This particular TCDF was tested as an adjunct to the LOTS Heavy-Lift Breakbulk Ship Pretest. During the pretest it off-loaded 20 Milvans (20-ft) and one 40-ft container that had been weighted with sand. Experience with this element of the system is still limited but more practice is expected before the test. Some techniques have been learned such as placing the crane as near perpendicular to the containers being unloaded as possible so that the container spreader bar when lowered is not at an angle over the container. Otherwise there are extensive delays and more manpower is required to wrestle the bar and container into alignment.⁷

Operationally, the TCDF would work the opposite side of the ship from the COD. The TCDF would also support the unloading of 40-ft containers (fully loaded, they may be too heavy for the crane-on-deck) and containers aft of the ship superstructure. It is not envisioned that the TCDF would be used to off-load any deployment cargo since the deployment phase would likely be completed prior to the arrival of the TCDF.

Ship-To-Shore Subsystem

Lighterage support will primarily consist of the use of LCM8s and LCUs. Lighterage is the most common element between the Army and Navy with two notable exceptions. The Navy has the only causeway ferry capability⁸ and the Army has

⁷ One of the data elements for collection should include the TCDF positioning angle with respect to the container being off-loaded. See Section III for further details.

⁸ The Army use of BC barges as lighterage is not considered in the same category because of the inability to drive equipment on and off.

the only air cushion vehicle. (Results of these two lighterage exceptions are of interest to both since the Navy has an on-going air cushion vehicle program. Also, the Army has expressed some interest in the causeway ferry approach to lightering.) One other exception is the use of amphibians for cargo transfer; the Army has three versions of the LARC (the LARC-V, LARC-XV, and the LARC-LX) whereas the Navy has only the smallest (LARC-V) and does not intend to add the larger versions to its inventory.

Navy lighterage resources to support the elevated causeway (discussed subsequently) are insufficient due to deployment commitments. This gap will be bridged by pooling LCU and LCM8 resources. Conversely, extending the use of Navy lighterage to cover the entire test period will provide some opportunities to examine support capabilities of the 1646-class LCU in sustained round-the-clock operations.

In the bare beach phase where tidal effects hamper the beaching of landing craft, it is anticipated that amphibians will be used extensively. Their employment will require particular attention to ensure that LARC-XVs and LACV-30s are not overloaded. To maximize transportation efficiency, it would be desirable for the LARC-LXs to lighter the heaviest containers. Also, to maximize the employment of amphibians, it would be desirable to off-load them near the beach versus at the marshalling site, thereby increasing the number of containers lightered per hour per vehicle. Although amphibians have the capability to transport containers from the beach to the marshalling site, the longer land distance greatly increases turnaround time. Trucks, for example, can more efficiently perform the land movement. With limited amphibian assets and with their associated high maintenance costs, it would be prudent to limit their use to those functions the amphibians do best, that is, crossing through the surf zone and loose sand to a cargo transfer point.

The causeway ferry, of which only one has been projected as being available during the test, currently is the primary Navy/USMC method of container lightering until the construction of an elevated causeway has been completed and extensive use of LCM8s and LCUs is possible.⁹ It is generally

⁹ The Marine Corps intends to employ an experimental vehicle, the lightweight amphibious container handler (LACH), which may permit some early employment of LCM8s and LCUs before the elevated causeway is available.

employed along with a frontend loader on the beach. Its availability in a LOTS-type environment is keyed to Service ownership and means for deployment. Deployment of causeways is possible on a conventional breakbulk ship but is limited to one or two sections per ship, depending upon the ship type. Deployment on amphibious ships does have an impact on cargo space but normally causeways are available to support the off-loading of LST type ships. Accordingly, it would not normally be available for use in what may be described as an Army bare beach effort.

In addition to lighterage requirements for containers there is also a requirement for lighterage to support breakbulk operations. No special type lighterage is required but the capability to support the concurrent off-loading of both containers and breakbulk cargo will be needed.

Shoreside Unloading

General. In the test the Army LOTS terminal battalion and USMC shore party detachment must be capable of handling both containerized and breakbulk cargo concurrently. This test requirement applies during the bare beach phase of the test for Army terminal service units and during elevated causeway operations for the amphibious forces. The equipment needed to support these separate functions will be provided in accordance with unit tables of equipment and appropriate task organization for conduct of each operation.

Bare Beach Operations. Establishment of the bare beach shoreside unloading system will be time-constrained. Initial preparations will be begun by advance parties and engineer units in accordance with deployment scheduling outlined previously and in Appendix B. Once the breakbulk ship with the LOTS equipment embarked has anchored, four days will be available to prepare the beach for container throughput operations.

Shoreside unloading operations in the bare beach mode will be exercised for a period of 5 days. During this time, cargo throughput will be accomplished as indicated in Table 2.6. Army transportation unit landing craft, amphibians,¹⁰ and other lighterage deployable on conventional and

¹⁰ Although both are amphibians, it is expected that the LACV-30 and the LARC-LX will be used to support containership operations only. The quantities of both now available are limited and data on their use with containers is important. Other amphibians can be used to transport breakbulk cargo.

heavy-lift breakbulk ships will be used. The last day of the scenario will include a period in which the containership is backloaded for the next phase of the test, Improved Beach for Amphibious Forces, which will not include the use of 40-ft containers.

TABLE 2.6
BARE BEACH OPERATIONS

	Test Day				
	T + 13	T + 14	T + 15	T + 16	T + 17
	Non-Mobilization Scenario Day				
	D + 28	D + 29	D + 30	D + 31	D + 32
Heavy-Lift Breakbulk Ship	Discharge 150 S/T Cargo, 75 Drums LCM Amph.	Discharge 300 S/T Cargo, 150 Drums LCM Amph.	Discharge 150 S/T Cargo, 75 Drums LCM Amph.	Backload 150 S/T Cargo, 150 Drums LCM Amph.	Backload 300 S/T Cargo, 150 Drums LCM Amph.
NSS Containership	Discharge 150 Containers & Equipment Amph. Landing Craft	Discharge 300 Containers (incl. 25 40-ft Cntrs) Amph. Landing Craft	Discharge 150 Retrograde 150 Containers Amph. Landing Craft	Retrograde 300 Containers Amph. Landing Craft	Discharge 50 Retrograde 175 Containers Amph. Landing Craft

Principal items in the Army shoreside container handling inventory are the 300-ton capacity crane for unloading landing craft and the 140-ton crane for unloading amphibians. The employment of amphibians and a 140-ton crane is rather straightforward but several alternative ways of operating the 300-ton crane at the beach have been proposed. Further discussion of these alternatives and the crane problem is contained in Appendix C. The objective for whatever method is employed is to attain maximum container throughput. The expected result of the method adopted for handling containers is a capability equivalent to the daily off-loading rates of the ship unloading system (discussed above) of 300 containers per day.

Preparation of beach routes, loading sites, and the marshalling area also will be time-constrained by the amount of equipment and number of personnel deployed in accordance with the scheduling and "sorties" discussed previously.

However, the 4 days following the arrival of the heavy-lift breakbulk ship are sufficient to complete off-loading and any additional site preparation not possible with the limited equipment deployed with the advance party.

Improved Beach for Amphibious Forces

To support amphibious force follow-on container and barge handling operations the mainstay for beach operations is the elevated causeway. The elevated causeway will have been erected prior to arrival of the containership. Data will be collected on its installation making note of times, numbers of personnel required, delays, and level of training and training activities which would influence extrapolation of results.¹¹

Operations using the elevated causeway and LACH are relatively straightforward. The first day (T+17) 300 containers will be off-loaded and the second day 250 will be off-loaded before backloading begins. Containers will be backloaded each day for 2 days. In addition to container handling, 600 short tons of breakbulk cargo and 300 drums of (simulated) POL will be off-loaded from the heavy-lift breakbulk ship at a rate of approximately 300 short tons and 150 drums per day. Table 2.7. illustrates the proposed scheduling and employment of lighters.

TABLE 2.7
IMPROVED BEACH OPERATIONS FOR AMPHIBIOUS FORCES

	TEST DAY			
	T + 17	T + 18	T + 19	T + 20
	MOBILIZATION SCENARIO DAY			
	D + 57	D + 58	D + 59	D + 60
Heavy-Lift Breakbulk Ship	Discharge 300 S/T Cargo, 150 Drums LCMB	Discharge 300 S/T Cargo, 150 Drums LCMB	- -	- -
NSS Containership	Discharge 300 Containers C/W Ferry Landing Craft	Discharge 250 Containers Retro 50 C/W Ferry Landing Craft	Retrograde 300 Containers C/W Ferry Landing Craft	Retrograde 225 Containers C/W Ferry Landing Craft

¹¹ Because development of the elevated causeway has been done on the West Coast, units in the LOTS test have had only limited exposure to elevated causeway operations.

During this phase SPS procedures will be exercised by Army units to monitor container and breakbulk/drummed cargo throughput. The primary means of cargo control and movement will be provided by a Marine Corps shore party detachment.

Once all containers have been retrograded to the containership, amphibious forces using the elevated causeway will begin stripping cargo from barges (two barges loaded with containers and two barges loaded with breakbulk cargo) on T+21. This event will be completed by T+22 and Marine Corps units then will be phased out of beach operations in accordance with joint doctrine.

Improved Beach for Terminal Operations

The improved beach for terminal operations phase of the test will use all Army items of equipment which would be available in a mobilization situation. For exercise purposes the scenario begins at D+58 and assumes that whatever shipping was required from the U.S. flag fleet to support deployment was available.

The principle item in this type operation is the "B" DeLong pier with a 140-ton crane mounted on it. In reality, two DeLong piers placed end-to-end from the beach will be required for the crane to operate far enough seaward so that landing craft do not ground out before they are close enough to be loaded. Installation of the DeLong piers will begin on T+15 and they will be ready for operations on T+17. The improved beach phase for terminal operations will be initiated on T+18 to be completed by T+23. During this period DeLong pier - LASH barge operations will overlap elevated causeway and container (amphibious) operations by approximately 2 days. Two barges will be loaded with containers and two barges with pallets and vehicles. Then the DeLong will be used to expedite container backloading by augmentating the elevated causeway. Once all containers have been retrograded, the elevated causeway will be used for barge unloading (discussed above) and all container throughput will be directed over the DeLong piers.

In the final days of the improved beach phase both the elevated causeway and "B" DeLong Pier will be operated together. During this period the back-up crane for the ship unloading system, a BD floating crane, will be worked along with the TCDF and COD to the extent possible to attain a maximum containership unloading rate. See Table 2.8.

TABLE 2.8
IMPROVED BEACH FOR TERMINAL OPERATIONS

Test Day						
	T + 18	T + 19	T + 20	T + 21	T + 22	T + 23
Mobilization Scenario Day						
NSS Containership	D + 58	D + 59	D + 60	D + 61	D + 62	D + 63
	-	Commence Cntnr Retrograde Operations at DeLong Pier**	Retrograde all Cntnrs ashore (20' and 40')	Discharge 300 Cntnrs to DeLong Pier	Discharge 150 Cntnrs to DeLong; Retro 300 Cntnrs from DeLong & 3 cranes at ship	Maximum Discharge to both shore-side systems; Use 3 ship cranes*
	-	Amph. Landing Craft	Amph. Landing Craft C/W Ferry	Amph. Landing Craft C/W Ferry	Amph. Landing Craft C/W Ferry	Amph. Landing Craft C/W Ferry
LASH Barges	Commence Stripping 4 LASH Barges at DeLong	Complete Stripping 4 LASH Barges at DeLong Pier	-	Commence Stripping 4 LASH Barges at Elevated Causeway	Complete Stripping of LASH Barges as Elevated Causeway	-
	-	-	-	-	-	-

* See scheduling changes if weather days are not used; paragraph on "Weather Days" pertains.

** Quantity to be retrograded subject to completion time of LASH Barge unloading.

* See scheduling changes if weather days are not used; paragraph on "Weather Days" pertains.
** Quantity to be retrograded subject to completion time of LASH Barge unloading.

Subject to test days lost due to adverse weather and ship availability, this period may be extended from 1 to a maximum of 4 days. The purpose of this exercise period will be to attempt to overload the two shoreside unloading systems with containers, initially individually and secondly together, to determine what the maximum handling capacity of the system is.

Management and Control System

Manifest data will be received and processed by the 24th Transportation Terminal Battalion documentation section using the mobile SPS van with a communications link via AUTODIN to a computer facility at the "logistics base" (at Ft. Eustis). The manifests will consist of "live" cargo traffic combined with some "canned" data transmitted by Eastern Area MTMC to the computer at Ft. Eustis.

As a part of the daily planning for receipt and onward movement of cargo, a COSCOM Materiel Management Center (MMC) and a COSCOM Movement Control Center (MCC) and a beach Transportation Movement Office (TMO) will be played by Headquarters, 1st Corps Support Command personnel. The MCC in coordination with the MMC will provide the Terminal Battalion, through the TMO, diversion and reconsignment instructions, changes in movement priorities, and specify clearance modes (in this case, all highway) for shipment to consignees.

All vehicles clearing cargo from the beach to and from the marshalling area will have proper documentation. TCMDs, properly completed, will accompany all shipments to consignees. The 24th Terminal Battalion documentation section will maintain records required in accordance with MILSTAMP and unit SOP's.

PRETEST AND LOTS SIMULATION MODEL RESULTS

Preliminary Field Test Data

For deployment planning, the times required for the unloading of equipment in port, off-loading into lighters off-shore, and establishing a cargo/container handling capability ashore have been verified in the conventional and heavy-lift breakbulk ship pretests. Adequate time has been provided for that phase of the test design (see Figure 1.1).

Limited data is available from the heavy-lift breakbulk ship pretest on container handling rates of the cranes on the beach, on a floating barge, on the shoreside "B" DeLong pier and in the assembly area. An analysis of these data is underway and the results will be considered in the final test design.

Lots Simulation Model Results

Having verified the times required to physically deploy major LOTS equipment items within scenario constraints, the next step was to determine if the available LOTS subsystem assets (cranes, lighters, trucks, etc.) could sustain planned throughput rates. For this purpose data on the capacities and capabilities of LOTS subsystem elements were input to the LOTS simulation model. For sensitivity analyses, ship-to-shore distances, lighter and truck speeds, and mix of lighters were varied. To the extent possible, considering the limited number of amphibian vehicles available, a "best" mix of available craft was determined to accomplish 300 containers per 20-hr day. Summaries of these runs are as shown in Tables 2.9, 2.10, and 2.11. For a detailed discussion of the model runs and test results, see Appendix D.

TABLE 2.9
SIMULATION RESULTS FOR THE BARE BEACH OPERATION

Lighters				Distance of Ship Off-Shore	Computer Time to Discharge 300 Containers (hr)
Amphibians		Landing Craft			
LACV-30	LARC-LX	LCM8	LCU		
1	3	6	0	1	17.5
1	3	0	4	1	18.3
1	3	12	0	3.3	19.9
1	3	0	8	3.3	19.9

TABLE 2.10
SIMULATION RESULTS FOR THE IMPROVED BEACH FOR AMPHIBIOUS FORCES

Lighters			Distance of Ship Off-Shore (nmi)	Computer Time to Discharge 300 Containers (hr)
Causeway Ferry*	LCM8	LCU		
1	2	7	1	18.7
1	2	11	3.3	19.6
* Four causeway sections.				

TABLE 2.11
TRUCK REQUIREMENTS FOR BEACH CLEARANCE

Truck Speed (mph)		Number of Containers Per Truck	Number of Trucks
Empty	Loaded		
10	10	1	10
10	10	2	8
20	15	2	6

BACK-UP AND CONTINGENCY CONSIDERATIONS

Since the overall test involves substantial expenditures of resources, its successful completion should not be jeopardized by such contingencies as storms, breakdowns of essential equipment, or absence of key personnel. These are foreseeable and their effects can be minimized with appropriate planning. This section outlines some of the considerations for an affordable "insurance" program to cut down the impact of possible contingencies.

Weather Days

The test plan makes allowance for days in which test operations must be curtailed or terminated because of weather effects. In the event that curtailment is necessary, a make-up or weather day(s) may be added to complete the scenario evaluation. In terms of descending priority operations to be evaluated are the bare beach, improved beach for terminal (joint) operations, and the improved beach for amphibious forces.

In the event weather days are not used or only partially used, Table 2.12 provides alternative container unloading objectives. The alternatives are aimed toward providing a three-crane maximum discharge rate to each improved beach unloading system to determine its saturation rate. During this period if queuing builds too rapidly, LACV-30s will be directed to a shoreside crane to reduce the backlog and provide a basis for stressing marshalling area capabilities. If redirection of the LACV-30 does not relieve the queuing sufficiently,

TABLE 2.12
UNLOADING OBJECTIVES FOR UNUSED WEATHER DAYS

WEATHER DAYS AVAILABLE	OPERATING SCHEDULE				
	T + 22	T + 23	W - 1	W - 2	W - 3
All Weather Days Used. (No change from Figure 1.1)	325 Cntnrs ABD Discharge 150 Cntnrs to DeLong Pier; Retrograde 300 Cntnrs from DeLong and Elevated Cause- way	475 Cntnrs ABD Maximum Discharge to both Systems			
Two Weather Days Used-- One day gained for operations.	325 Cntnrs ABD 3-Crane discharge of 200 Cntnrs to DeLong; Retrograde 250 Cntnrs from Elevated Causeway & DeLong	375 Cntnrs ABD 3-Crane discharge of 200 Cntnrs to Ele- vated Causeway; Retrograde 250 Cntnrs from Elevated Causeway & DeLong	450 Cntnrs ABD Maximum Discharge to both Systems		
One Weather Day Used-- Two days gained for operations.	325 Cntnrs ABD 3-Crane discharge of 200 Cntnrs to DeLong; Retrograde 250 Cntnrs from Elevated Causeway & DeLong	375 Cntnrs ABD 3-Crane discharge of 200 Cntnrs to Elevated Causeway; Retrograde 250 Cntnrs from Elevated Causeway & DeLong	425 Cntnrs ABD Retrograde 200 Cntnrs; Maximum Discharge to both Systems	375 Cntnrs ABD Maximum Discharge to both Systems	
No Weather Days Used-- Three days gained for operations.	325 Cntnrs ABD 3-Crane discharge of 200 Cntnrs to DeLong; Retrograde 250 Cntnrs from Elevated Causeway & DeLong	375 Cntnrs ABD 3-Crane discharge of 200 Cntnrs to Elevated Causeway; Retro 250 Cntnrs from Elevated Cause- way & DeLong	425 Cntnrs ABD Retrograde 200 Cntnrs; Maximum Discharge to both Systems	225 Cntnrs ABD Retrograde 350 Cntnrs; Maximum Discharge to both Systems	475 Cntnrs ABD Maximum Discharge to both Systems
					Off-Load Crane; Inspect Ship
					Off-Load Crane; Inspect Ship
					Off-Load Crane; Inspect Ship
					Off-Load Crane; Inspect Ship

other amphibians or the causeway ferry may be used to bring the system back into balance without slowing or stopping the ship unloading system. Each weather day alternative in Table 2.12 terminates with a maximum discharge to both improved beach facilities working together. (See "Improved Beach for Terminal Operations," pg. 2-21.)

Sea state is the most likely cause of weather delays. How much operations may be curtailed and to what degree ship unloading, lighterage, and shore-side unloading systems are affected by worsening sea states are all important elements of the evaluation. A significant weather change at any point in the exercise will permit an evaluation of its impact on ship unloading methods (COD and TCDF), lighter resources, and whatever shoreside unloading method being used at the time.

During the test period daily weather and seastate forecasts and severe weather warnings must be available to the JTD and promptly distributed to operational command and evaluation personnel. Forecasts can provide time for the JTD to plan and execute changes in operations. A series of alternative schedules will permit each unloading system to be activated during the heavy weather condition so that data can be collected. It would be desirable to accomplish at least 40 iterations with each system so that statistical reliability of the data will be relatively high. On the other hand, a forecasted period of severe weather may not permit sufficient time for each system (crane-on-beach, elevated causeway, and DeLong pier) to conduct 40 unloading iterations. To the degree possible it is better to exercise each system proportionately rather than obtain no data at all on one of them within the severe weather period.

In order to plan for such contingency schedules special forecasts of sea state must be arranged. Additionally, attention should be paid to forecasts of cessation of high sea states after the exercise has been temporarily shut down. Experience in OSDOC II (and historically in past over-the-beach operations) indicates that resumption of work has lagged unnecessarily far behind a return of reasonable sea states.

In an actual LOTS operation a cessation of throughput activity due to weather provides additional time for needed maintenance of equipment and for rest. In this exercise similar use can be made of the time along with

appropriate adjustments in LOTS assets to reduce system bottlenecks.

Because of overriding safety considerations, the decision to continue or to cease operations during heavy weather conditions is reserved for the JTF Commander.

Back-Up Equipment to Ensure Throughput

The exercise cannot be put in jeopardy from the breakdown of single items of equipment or from other conditions that might prevent its effective use. At the same time, it would not be appropriate to go to the expense of providing back-up or alternatives for all equipment. A judicious choice of back-ups and alternatives must be made that will cover the most likely and, to some extent, the most drastic of the foreseen contingency possibilities. In general, special attention must be given to throughput bottlenecks. Table 2.13 illustrates the employment of cranes and their back-up support through each phase of the test.

TABLE 2.13
CRANE EMPLOYMENT SCHEDULE

Crane Resources		Scenario			
		Crane Support For Bare Beach Operations	Crane Support Of Improved Beach For Amphibious Forces	Crane Support Of Improved Beach For Terminal Ops	Crane Support for Improved Beach- All Major Facilities
<u>Ship Unloading</u>					
Crane No.	LOTS Function				
1.	Crane-On-Deck	No. 1	No. 1	No. 1	No. 1
2.	Temp Cntr Dschg Facility	No. 2	No. 2	No. 2	No. 2
3.	BD/YD Crane (Backup)	(as required)	(as required)	(as required)	No. 3
<u>Shoreside Unloading</u>					
4.	300T Crane-On-Beach	No. 4	(inactive)	No. 4 (off-loads Amphibs)	No. 4 (off-loads LACV-30)
5.	140T Amphibian Unloading Crane	No. 5	(Crane		-
6.	140T DeLong Pier Crane	(not available)	relocated*	No. 6	No. 6
7.	140T Crane-On-Causeway	(inactive)	No. 7	(inactive)	No. 7
8.	LACH	(inactive)	No. 8	(inactive)	(inactive)
9.	(300T Backup)(Leased)	Backup No. 4	(inactive)	Backup No. 4	Backup No. 4
10.	(140T Backup)(Leased)	Backup No. 5	Backup No. 7	Backup No. 6	Backup No. 6 and
* Pending outcome of March, 1977, training tests.					

Ship Unloading Cranes. A back-up is needed in case the crane-on-deck or the TCDF crane become inoperative for long periods of time. While conceivably the crane-on-deck could be replaced by a second crane-on-deck, the time required for the substitution would be prohibitive. For the TCDF a crane substitution could perhaps be accomplished more quickly but this delay and its replacement's potentially lesser productivity could delay the exercise or reduce throughput by 50 percent or more. Although not a completely satisfactory back-up for either of the two cranes, a floating crane of sufficient reach and capacity should be available. Presumably, it would generate less throughput than either of the cranes it would temporarily replace, but it would permit continued testing of other system components at reduced throughput rates. In addition, the floating crane will be able to augment the TCDF and COD during retrograde operations. It can also be used in the final phase when an attempt will be made to stress the two major shoreside unloading facilities by accelerating ship unloading.

Shore Cranes

Two back-up cranes will be needed to support shoreside unloading, a 300-ton and a 140-ton crane. Since the Services do not have these additional assets, both will have to be leased. Positioning of these cranes should be such that they will be out of the way of other beach activities but still can replace the deadlined crane with minimal time losses. Thus, road approaches and ramps should be readied in anticipation of need. This requirement should also encompass some available back-up means to reposition the deadlined crane in the event it becomes immobile.

One crane must be relocated to meet the diverse scenario and crane requirements in the relatively short time available. Initially a 140-ton crane is needed to unload the LARCs and LACV-30s and another, two days later, is required to handle containers and barge cargo across the DeLong pier. In order to reposition the crane a ramp system is required capable of supporting the crane. This area will be investigated during a March 1977, training test to determine problems and timing of ramp installation.

Lighters

Operational bottlenecks caused by inoperability of individual lighters (except LACV-30) are not critical to cranes because the total work load of lighters is shared—they operate in parallel. For the test, however, certain conditions make back-up considerations for lighters important. One is an operational problem during the bare beach phase due to sandbars at Green Beach. If the planned dredging is not possible or if the dredged channel fills in prematurely, the sandbar could limit landing craft operations to periods near high tide. Then amphibians have to be relied on for a large share of throughput. Potentially, the most productive amphibian vehicle is the LACV-30 and there are only two of them on-hand. Thus, all other available wheeled amphibians may be called on as a back-up for greater-than-planned use. Provision for substantial numbers of back-up amphibians is appropriate. Investigation of the possible use of a reserve unit for this back-up role is encouraged.

Another back-up possibility for the bare beach sandbar contingency is to have Navy-type causeway ferries on-hand. The ferries are known to be in short supply. However, if feasible, arrangements should be made for loans from Navy operational units for emergency use during the test. Also, if available, AMMI barges should be considered for standby use.

SITE SELECTION

Test Site

Ft. Story, Virginia was originally selected for the LOTS preliminary field tests and main test based upon the following criteria:

- Proximity to majority of participating units.
- Proximity to major commercial ocean terminals (access to commercial test vessels).
- Contiguous to or immediate vicinity of military post for administrative/logistic support.
- Ocean beach at least $\frac{1}{2}$ mile in length, 300 ft in depth, with at least two access roads.

- Off-shore anchorages of 50-ft depth with varied, representative, moderate sea conditions. Proximity to sheltered anchorages for adverse weather safe haven.
- Twenty-five to thirty acres of relatively open, flat area for cargo marshalling, equipment operation, and command and control facilities.
- Beach gradient suitable for both landing craft and amphibians.
- Proximity to aviation support facilities.

In a final review following completion of the preliminary field tests (April-November 1976), Ft. Story remained the best choice although the beach gradient and presence of sandbars were a serious obstacle for beaching container-laden landing craft within reach of a crane on the beach (discussed in Appendix C).

Beach Site

As noted in the LOTS Feasibility study, LOTS operations could be conducted in a wide spectrum of sites from a topographic view. However, from a survey of areas considered strategically important, useable beaches are available for LOTS operations. From the standpoint of beach gradient the great majority (81 percent) of all the usable beaches have gradients flatter than a ratio of 1 to 61. From that standpoint Green Beach at Ft. Story can be considered as typical of landing sites in strategic areas.

During the conduct of preliminary field tests the presence of sandbars off-shore greatly hampered landing craft attempting beach landings except at high tide. The only beaches with better approaches were Red and Blue Beaches, both of which face the Chesapeake Bay. The difference in surf conditions between the beaches facing the bay versus Green Beach was studied.¹² The conclusion reached was that Green Beach would, on the average, experience higher waves and more typically represent an ocean beach than would either Red or Blue Beach, as indicated in Table 2.14. With the selection of Green Beach the sandbar problem remains which the Army plans to breach with dredging simulating blasting channels for landing craft.

¹² Victor Goldsmith, Virginia Institute of Marine Science, Letter to Wm. H. Sutherland, ORI, dated 8 December 1976.

TABLE 2.14
ANTICIPATED WAVE AND CURRENT CONDITIONS AT
CAPE HENRY, VIRGINIA- VICINITY*

	Average		Maximum		Wave Energy Concentration (i.e., Wave Refraction)	Anticipated Tidal Current Activity (Relative)	Maximum Combined Conditions	Relative Speed Of Natural Filling Of Dredged Holes, etc.
	Ht(min)	T(sec)	Ht(min)	T(sec)				
Red-Blue Beach	≥0.6	3-5	2	7	Low (relative to other Southern Bay Beaches) ex- cept for winds from North ≥ 25 kts	Higher	Ebb tide, with large swell entering Bay Mouth of strong (≥ 25 kts) winds from northerly quadrants	Lower
Green Beach	≥1.0	6-10	3	12	High (relative to adja- cent ocean beaches) for short period waves (4 sec) and relatively low for long period waves except for 10 sec waves from NE thru SE directions; and longer waves from E.	Lower	Large, slow moving, ex- tra tropical storm at spring high tide	Higher (especially with large waves)

* Furnished by Victor Goldsmith, Virginia Institute of Marine Science.

CONTAINER/TEST CARGO REQUIREMENTS

General

In order to achieve a high degree of realism in the exercise, most containers will be loaded with "live" cargo with a range in weights comparable to normal resupply. Simulated (dummy) cargo will be used after sources of real cargo have been exhausted.

To insure that sufficient numbers of containers are available to evaluate the full capability of the LOTS system in sustained, around-the-clock operations, a total of 600 Milvans and 25 commercial 40-ft seavans are required. Twenty-five of the Milvans will be loaded in LASH barges.

For breakbulk cargo operations, 600 short tons of palletized exercise cargo and 300 drums of simulated POL will be prepared at Ft. Eustis and loaded on the heavy-lift breakbulk ship. Four LASH barges will be loaded with a mix of palletized cargo and vehicles.

All cargo will be documented/manifested in accordance with MILSTAMP.

Container Position/Loading Plan

It is currently planned that containers will be shipped to and loaded at the following locations:¹³

- Mechanicsburg Depot, Pennsylvania, 50 chassis and 400 containers; 10-13 short tons of cargo will be loaded in each container.
- Norfolk, Virginia, 30 chassis and 30 Milvans; USMC will load an estimated 8 short tons of cargo per container.
- Richmond Depot, Virginia, 125 chassis and 125 Milvans; for loading an estimated 21 short tons of cargo per container.
- Ft. Eustis, Virginia, 20 chassis and 20 Milvans; for multi-addressee cargo, an estimated 10 short tons of cargo for loading in each container.
- Ft. Eustis, Virginia, 25 Milvans; no simulated cargo (containers will remain empty).
- Fifty Milvans to Ft. Story.
- Ft. Eustis, Virginia, twenty-five 40-ft containers; simulated cargo (20-35 short tons of cargo).

Backloading Operations

Backloading full containers aboard the containership is a test-peculiar requirement that could unduly delay exercise events unless appropriate stowage and movement plans have been prepared. Normally in a LOTS environment retrograde operations would include few loaded containers. In the joint LOTS test nearly all of the containers will be backloaded with cargo. Since retrograde operations constitute about 40 percent of all container handling and two discharge cycles

¹³ Joint Test Directorate Message, DTG 262119Z, January 1977, to JCCO, Tobyhanna, PA.

are dependent upon retrograde operations being completed on schedule, careful planning must be accomplished to insure a steady flow of containers to the ship in a proper loading sequence.

Approximately 30 percent of the containers will be loaded to near maximum capacity (about 21 short tons). The lightest containers will be loaded with about 8 short tons of cargo. If backloading is not properly accomplished, unsatisfactory conditions could result such as making the ship unseaworthy or causing a list to the extent that no containers can be loaded or off-loaded without considerable difficulty. Accordingly, loading plans need to be developed and adequate control established to insure that these conditions do not occur.

Breakbulk/POL Cargo Loading Plan

The below quantities of breakbulk cargo will be loaded aboard the heavy-lift breakbulk ship for use in those portions of the exercise requiring simultaneous handling of breakbulk and containerized cargo:

- Three hundred drums to Ft. Eustis for simulated POL.
- Six hundred short tons of palletized exercise breakbulk cargo at Ft. Eustis, Virginia.

III. ANALYSIS PLANS AND DATA REQUIREMENTS

KINDS OF ANALYSES PLANNED

The basic objectives of the joint LOTS test requires the following principal kinds of analyses:

- An assessment of deployment capabilities
- A validation of throughput planning factors
- An evaluation of the cargo management system
- An evaluation of force structure and manpower utilization.

Separately to a degree, but largely as part of the above, the following kinds of analyses are also part of the work:

- Making productivity analyses and tradeoffs
- Making critiques of techniques and equipment selection
- Evaluating command and control of the operations, particularly with respect to throughput, and
- Unplanned analyses contributing to the above.

The analyses under each of the headings will make use of data and information not only from the test results but also from outside sources such as reports on prior tests. In all of the analyses listed, determining the effects of the environment on test results (particularly sea state) will be a goal.

Assessing Deployment Capabilities

In the main test, and in the pretests made before the main test, only selected samples of the total deployment requirements can be undertaken. In general, the ships selected and the equipment chosen for tests represented difficult deployment problems. They were designed to establish feasibility of deployment for specific equipment and to find limits to weight and size capabilities. In analyzing the overall test results, the results of limit-tests must be put into a quantitative perspective that includes lifts of equipment whose size and weight are well below the established limits. In short, the overall shipping needs—not just the equipment so far sampled—will have to be considered. This analysis can have impacts on the choice of LOTS equipment for a future emergency. The number and types of ships needed, their probable availability, their schedules of arrival at an objective area, and the balance of LOTS equipment they can carry must be considered during such deployment analyses. Broad planning factors on deployment times and manpower needs will be one result of deployment analyses.

The analyses will extend the ship availability information already discussed in the LOTS Pretest Design to greater detail.¹ It will possibly use already-made "snapshot" studies that can show the probability of particular ships being available in specific U.S. ports on short notice during future emergencies. In such studies of availability of ship types as already noted in the LOTS Pretest Design a sharp distinction is made between those types committed by their owners for nearly immediate use in a declared mobilization emergency and those that may be available for emergencies short of mobilization. Such analyses can have strong impacts on the choice of ship types likely to be available in the two circumstances, and hence on the types of LOTS equipment that can be counted on. For example, it appears highly unlikely that SEABEE ships, of which there are only three currently operating, could be made available early enough in a non-mobilization emergency. With little room for exception, this fact limits the use of the B DeLong barge to mobilization emergencies.

¹ Operations Research, Inc., Design of Preliminary Field Tests for the Logistics-Over-The-Shore (LOTS) Test and Evaluation Program, ORI Technical Report No. 993, 6 January 1976.

Note that part of the deployment analysis will depend on the thorough documentation of LOTS equipment discussed earlier. Since each operating unit will be required to produce shipping documentation for any major equipment brought to the test site, it should be possible to reconstruct what actual shipping requirements would have been in a real emergency.

Validating Planning Factors

A high-priority part of the analysis of the main test results will be establishing throughput planning factors for the available systems and for equipment and units that work within the systems. Present planning factors for handling containers are generally estimates because the military capability is relatively new and opportunities to measure them in real operations or in tests have been lacking. Hence, many planning factors are simply based on extrapolations of commercial equipment capabilities.

Establishing planning factors is envisioned as a four-step process. The first step is to get timing data for specific conditions timed in the test. Second, it is necessary to determine in what respects an "average" or "to be expected" system differs from the one timed. In this step two aspects are involved. One is correction of artificialities inherent in a test as compared to real life. An example is the retrograde movement of non-empty containers in a greater ratio to empties than would occur in real life. Corrections for this will be based on the results of timing of empty and full containers during retrograde movement. A second aspect of step two, finding what an "average" system is compared to the one being timed, requires the analysis team to acquire data from sources independent of the test.

Establishing planning factors calls for analysis of both (a) the repetitive once-per-lift basic data time required per lift, and (b) on data for making lift gear ready, hatch cover moving and the like, which do not occur as frequently as once per lift. (Note that some or most of (b) may be repetitive.)

The analysis is planned to establish basic system throughput and throughputs of the various components of the system on a "building block" basis. Factors will be calculated to show adjustments to throughput. One important adjustment would be for sea state, assuming that a sufficient quantity of operations in significant sea states, in fact, occur during the test. Other adjustments to be considered will be for different ship types and sizes, and for different types and quantities of ship unloading equipment.

Evaluating the Cargo Accounting and Distribution System

Keeping track of where each container or other cargo is located at any given time and arranging that it be directed and carried to its appropriate inland destination are necessary functions the LOTS test is intended to exercise and monitor. The analysis of the test results for this area will include assessing answers to questions such as the following:

- Does the system provide a complete "audit trail" as cargo moves from each part of the system to the next?
- Does the system, in fact, account for all the cargo handled with none left out?
- Does the system delay operations and by how much?
- Is the system responsive to changes in such matters as priorities?
- Is there provision for handling misdirected or misrouted cargo from outside of the system being tested?
- At any particular point is there visibility of what is awaiting discharge and on hand (intransit storage)? Can one tell what is the oldest cargo on hand?

- Is the cargo data entered on various control sheets complete and accurate? What are the types and frequencies of errors?

Manpower Utilization and Force Structure

For most units involved in the test TO&Es are current and the manning levels have undergone numerous reviews and up-dates based on experience. The exception is the U.S. Army Transportation Terminal Company (Container), a newly organized unit. The joint LOTS test will provide an opportunity to evaluate the manning level of the company in all areas: operations, administration, supply, and maintenance. Daily records will be required to account for the assignment of personnel by type of duty.

With regard to force structure analysis, movement requirements in support of most likely contingency situations will be compared with current LOTS unit capabilities. The numbers of LOTS units by type (with capabilities as validated in the joint LOTS test) to accomplish the currently planned time-phased ship unloading requirements will be determined. As a part of the deployment analysis, an estimate of total shipping requirements needed for these LOTS units to support contingency plans will also be made.

The USMC Shore Party Detachment will be task organized to accomplish the level of effort envisioned in the test design. Appropriate rosters will be available for subsequent evaluation. Any required adjustments in personnel due to changes in support requirements are to be recorded as they occur.

Productivity Analyses

All the throughput systems that are to be tested (and some that must be synthesized to correct such artificialities as the single crane-on-deck instead of the two planned for real operations) can be expected to have bottlenecks. In principle, the location of the bottleneck should be controlled by balancing the throughput system, at least to the extent that the resources available and applicable permit. The bottleneck will then be confined to the part of the system that has the most basic limitation. In general, this part will be the ship-to-lighter cargo transfer; other parts of the system would seem to be more readily augmented with parallel operations or their output otherwise increased.

Time data on any one element of a throughput system may well be used to improve the balance of the system. That is, it will be used to show how to eliminate some delays. (Presumably, most of the time not all delays would be eliminated, since that would shift the site of the bottleneck.) The results of the productivity analysis will, of course, be reflected in the throughput planning factors already discussed.

Critiques of Operating Techniques and Equipment Selection

Independent of the productivity analyses, which are addressed to improving overall throughput, there can be improvements or other adjustments to the individual sectors of the system with the goal simply to use less resources for a given operation. Obvious examples might be: in the analysis a crew size may prove greater than necessary or a crane used may have had a reach substantially greater than needed. Note, though, that the analysis here would be after-the-fact critiques of the use of equipment that has been officially designated as operationally capable for use during military emergencies and is not oriented toward equipment development.

Critiques of Command and Control of Throughput Operations

Not covered in the above are the communications-effectiveness and other aspects of the control of operations during the test. In even the smoothest running and most thoroughly prepared operations various adjustments have to be made as a throughput operation progresses. How quickly the command net responds to needs for adjustments, how well the needs for changes are met, and how various minor emergencies are dealt with must be observed, recorded, and analyzed. Analysis of this topic will clearly use a more subjective approach than some of the other kinds of analyses discussed above.

Unplanned Analyses

Experience indicates that nearly all tests and experiments provide requirements for analyses that were not planned before the tests. Most such analyses will be based on data that is collected routinely by the data takers. There will also be some data collected by skilled observers that can be used for additional analysis requirements.

IMPACTS OF ANALYSES ON DATA REQUIREMENTS

The various types of analyses outlined in the previous section each require data inputs from the test. (While they also require additional information and data from outside the test, discussion of such material is outside the scope of the present report.) This report outlines the way the data needs are derivable from the analysis needs and gives detailed examples. Being an interim report it does not show the full detail of all data needs. Sufficient material is shown to establish:

- An orderly procedure for showing what data will be required, and
- A tentative requirement for the timeliness, accuracy, and the level of detail of the needed data, so that order-of-magnitude estimates can be made of the tasks involved in collecting, storing, and reducing the needed data.

Kinds of Data Required

In the pretests already accomplished the most basic of the information collected was whether particular equipment could, in fact, be deployed. In the main test the emphasis is changed. The most basic information to be collected is on how long the various operations take. This means that two kinds of information must be derived from the data for every one of the planned operations:

- Descriptors of what took place (with quantitative measures where possible, such as how far in feet or how heavy in tons) and
- How long it took.

Clearly, either one of these without the other will usually have no meaning, just as a military cost estimate in dollars means little unless what the dollars will buy is spelled out in detail. Thus, the result of the timings made during the test must, in effect, always be paired information. The time record itself is a single number showing when an event happened, but the descriptors for the timed event are multi-dimension and "multi-fact." That is,

they are multi-dimensional—how far cargo is moved and how heavy it is; multi-fact—what was moved, what equipment was used, where, and in what circumstances.

Time Records. Note that the primary record of time taken as data during the test will be the record of the times for a series of events, on the principle of a log. Time shown will be to the appropriate accuracy in minutes and seconds. Elapsed times will be obtained later by subtracting the time for one recorded event from the time of a second event. Direct records of elapsed time, as in stopwatch readings, will not be relied on. There are three main reasons for insisting that the primary data record be in this time-of-event form. One is that the time recorded in this manner permits the effects of sea state, wind and the like to be readily identified with particular events. A second is that elapsed times calculated by subtractions are prone to leave out small delays. A third reason is that some analyses are planned that will make use of times from two or more timers, to show effects of one operation on another. An example of this is the effect of maneuver and tie-up time for lighters on the ship unloading cycle. Under some circumstances one lighter can replace another and often can have accomplished most of its mooring to the ship while the lifting gear is picking up the next lift from the ship hold.² Analyses such as this, depending on observations reflecting the coordination between operations, would make use of data from two observers, for example, one of the craft unloading cycles and the other of the lighter's activities. The accuracy of the results depends on careful synchronization of watches.

Descriptor Records. As mentioned above, each time notation must have unmistakably paired with it all needed information on what occurred at the instant of time recorded. Properly designed and filled-in data forms help assure that these data can, in fact, be retrieved after the test period. The forms, though, cannot be designed to foresee all the possibilities, and the timers must be trained to separately note unusual circumstances.

A part of the descriptor record is information on the environment in which the timed operations take place. Special sea state data will be collected.

² For examples relating to breakbulk cargo operations see "Analysis of Means For Moving Logistic Cargo From Ship to Shore," Operations Research Office, ORO Technical Memorandum ORO-T-361, November 1957.

Among the lessons learned from the LOTS pretests is the importance of selecting suitable locations for measuring platform-motion effects. The effect on the motion of a lighter in the lee of the ship, for example, may be analyzed if appropriate measuring positions are selected and locations recorded along with appropriate sea state data. The sea state and platform motion data should include spectrum-type presentations for analysis purposes.

The records for individual operations do not need to repeat information already being collected on the environment. However, data takers should note significant effects of environment on the operations they are observing. For example, the following should be noted when the impacts are significant:

- "Go-No Go" (trafficability) for transport operations in sand or on MOMAT or pavement.
- Terrain interference with crane and storage operations, and particularly, slopes for LACV-30 operations.
- Visibility in twilight or night operations.
- Effects of wind, sudden showers, and the like on personnel and equipment that cause significant slowing down of operations.
- Observed effects of heat or cold on personnel effectiveness or on equipment.
- Surf effects that impact on the operations observed, such as a requirement for bulldozers to assist landing craft.
- Wave effects on cranes and lighters, e.g., attaching spreader bar, pendulation of lifts, impacts of lifts in landing craft, difficulties in tying up, etc.
- Effects of currents on maneuvering of lighters (when significant).

Data on Beaches, Waves, and Platform Motions

The same type of data as collected for pretests in the form of beach surveys, wave data, and platform motion data will be needed for the main test.

A detailed beach survey that emphasizes sandbar configuration will be required by the JTD for planning purposes well before the test and again within a few days of actual operations. If a particularly heavy storm occurs during the time between the two surveys, an additional survey should be considered. During the test period frequent checks on the depth of dredged channels should be taken and made a matter of test records. Similarly, data on depths should be regularly collected at shoreline transfer operations (DeLong and elevated causeway).

Data on wave and platform motion will be collected in a way similar to that used in the tests of the breakbulk ships. Additional platform motion data for the TCDF and/or the crane-on-deck may be collected in conjunction with measurements of crane stresses by COTS program personnel. Data so collected is not part of the responsibility of the test directorate, but any platform motion data available from this research effort should be requested and incorporated in LOTS test data.

Data on waves and platform motions should be presented in the same form as the previous pretest results except for the addition of information in the form of spectral analysis. These data permit possible future comparisons to be made between theoretical predictions of platform motion and actual operations.

Precision With Which Data is Recorded

Time Records. In the pretests, which were primarily concerned with deployment and in which the elapsed times of most concern were substantial fractions of an hour, recording of time to the nearest minute was sufficient. Any errors caused by imprecision of measurement were likely to be only a small percentage of the total elapsed time. For the parts of the main test concerned with deployment capabilities, this degree of precision continues to be appropriate. For throughput analyses, though, much more accurate timing of shorter time segments (e.g., parts of the lift cycle) will be required. The records for these should be to the nearest second. This precision will provide reasonable percentage accuracies for elapsed times that are in fractions of a minute.

Physical Measurements. The precision with which records of distance and weight are to be recorded for the operations depend on the particular operations being studied. For some examples, in ship-to-shore distances, errors

in tenths of a mile are accepted and expected. For operations in which a lighter is being loaded, no notation of the available clearances is usually needed since it is available from known dimensions. However, in the event that a previous container has been poorly located, an estimate of available clearance should be recorded by the observer if the clearance, in fact, slows down or otherwise impacts on the operation.

For situations where near-maximum reaches are being made by a crane, careful note of distance to the nearest foot and actual weight (from cargo list or other source) is required to show why a particular lift is marginal or not possible. Except for clearances, timers will normally not be asked to provide estimates of distances. Measurements will be made when necessary by other designated personnel.

Specifications will be made of the accuracy required for foreseen special analysis needs. Otherwise, goals of within plus or minus 10 percent of the actual value of distance or weight recorded should be used as a guide for constructing forms or instructing data-takers.

Increased Detail of Repetitive Data

During the main test, time data on all once-per-lift repetitive cargo transfer cycles will be recorded in terms of six basic elements. Each cycle will show three such elements for the non-load (or empty) half of the cycle and three corresponding elements for the loaded part of the cycle. The basic elements are listed and further defined in some detail in Table 3.1 but, in short, the lifting device does the following:

- | <u>Empty</u> | <u>Loaded</u> |
|--|---------------------------|
| A. Move empty (i.e., move away from previous recently disconnected load toward the new load) | D. Moves loaded |
| B. Positions itself empty close to new load | E. Positions the load |
| C. Connects (i.e., the empty lift device) to the load. | F. Disconnects from load. |

TABLE 3.1
BASIC ELEMENTS OF CARGO TRANSFER CYCLE FOR CRANES,
SHIP BOOMS, FORK LIFTS, AND OTHER MHE

Short Title for Subelement	Description of What is Accomplished During Subelement	Start of Basic Element	and	End of Basic Element
"Empty" Basic Elements				
A. Move Empty	Lifting device moves from previous load to vicinity of new load (gross movement of lifting device)	Time when lifting device is clear of previous load	to	Time when lifting device is in close proximity to new load to be lifted
B. Position Empty	Lifting device moves from near load to an accurately located position (fine movement of device)	Time when lifting device is in close proximity to new load	to	Time when lifting device is positioned ready to be connected
C. Connect to Load	Loading and lifting device are connected together	Time when lifting device is ready to be connected	to	Time when device is connected and the lift of load begins
"Loaded" Basic Elements				
D. Move Loaded	Load is moved to vicinity of new location (gross movement of load)	Time when device is connected and lift of load begins	to	Time when load is in the vicinity of new location
E. Position Loaded	Position of load is adjusted (fine movement of load)	Time when load is in the vicinity of new location	to	Time when load is accurately positioned
F. Disconnect Load	Load is disconnected from the lifting device	Time when load is accurately positioned	to	Time when lifting device is clear of load

Data previously collected on breakbulk operations in essentially the above form show that: this form presents no insurmountable collecting problems, and data from different operations on the same subelement can sometimes be compared and analyzed. In the OSDOC II tests data in the above detail (or even in still greater detail) were collected. Mainly because there were insufficient sustained operations for data generation, the analysis could not explore the elements in detail. It is recognized that for some operations it will be difficult or impossible to accurately separate some of the elements. Elements B and C, for example, may be difficult to separate if the operation involves a skilled crane operator and an automatic spreader bar.

A few operations in the main test will require that some of the above basic elements be divided into subelements to permit making particular analyses. For example, for analyzing lift truck operations from a causeway ferry to a point on a beach, the "move empty" and "move loaded" elements must be subdivided into "move-on-causeway" and "move-on-beach." This permits the analysis to be used in predictions of throughput for longer or shorter distances on the beach, longer or shorter causeway ferries, and fewer or more lift trucks. During continuing refinement of the data collection plan now in progress these requirements will be developed in coordination with the JTD planning staff.

Specific Samples of Analyses and Resultant Data Needs

Tables 3.2 and 3.3 show how two selected samples of analysis can be tied into the needs for data and for data reduction. One shows portions of the data needed for comparing effectiveness of certain lighters. The other shows data needs for a comparison between the crane-on-deck concept and the TCDF. Note that data on the subelements of time discussed above are important for some of the analysis.

Quick-Response Data Requirements

Quick-response information on the test results—particularly throughput results—will be required on a daily basis. The purpose of this information is primarily to monitor the progress of the test aspects of the operation. Secondary purposes are 1) to provide an assurance that the data is being collected in an appropriate manner—that is, a kind of quality control on the data collection process itself, and 2) as a check on the results provided through the operational commander's report. Such quick response data will of necessity be largely unedited.

To monitor the test progress, information must be supplied on what has been accomplished by the system as a whole and by the principal components of the system. The information must be in a form such that the users—the test evaluators—can readily ascertain whether:

- The tests are being performed on schedule.

TABLE 3.2
SAMPLE ANALYSES REQUIRED, AND IMPACT ON DATA COLLECTING (SERVICE OBJECTIVES 4, 5 AND 6)

Operational Comparison Or Variable Being Studied	Mechanism By Which Variable Affects Operation	Requirements For Data on Dimensions, Equipment Type, ect. (I.e., Non-Timing Data)	Requirements For Non-Repetitive Timings	Requirements For Repetitive Timing Subelements	Needs For Data Reduction
Amphibians and ACV, land craft and associated trucks and cranes		Distance, ship to beach Beach to inshore storage area or transfer point. Kind of going (beach or road)	Seastate of each run, weights for each con- tainer Refueling times, fre- quency maintenance down- times		
	Docking and undocking (where applicable) Distances, speeds and times		Times to move from ship- to-shore, shore to trans- fer point, intermediate points.	Detailed repetitive timing of ship-to-shore and shore- to-transfer point required. Breakdown for easy parts of run versus hard parts (I.e., road and beach) on a sample basis.	Net docking and undocking times, rates of speed on water, on land.
	Cargo transfer times	Type, make, capacity of cranes. Number of parts in line. How much space is available for point- of-rest operations when clearance transport is not available (I.e., space available for how many containers	Time for shifts in crane positioning, necessary re- rigging.	Detailed subelement of delays when there is no truck available. Center of gravity problem on ACV requires accurate spotting and "trials" to achieve proper trim.	Containers/tons per hour of transfer time.
	Capacities	For ACV, capacity will be a function of amount of fuel on board. Record of fuel on board at each loading needed.	The ACV may be limited to one container if containers are heavy. Thus the weight for each container must be recorded, as well as amount of fuel aboard.		Curves of fuel consumption rates at different speeds and different weights, over water and over land.

TABLE 3.3
SAMPLE ANALYSES REQUIRED, AND IMPACT ON DATA COLLECTING (SERVICE OBJECTIVES 3.1 THROUGH 3.7)

Operational Comparison Or Variable Being Studied	Mechanism By Which Variable Affects Operation	Requirements for Data on Dimensions, Equipment Type, Etc. (i.e., Non-timing Data)	Requirements for Non-Repetitive Timings	Requirements for Repetitive Timing Subelements	Needs for Data Reduction
Comparison: Crane-On-Deck vs. TCDF	Different position of crane relative to lift, resulting in:	Wave size and direction; lighter type; number of hatches on ship; size of hatches; number of containers per hatch; number of parts in hoist line; kind of spreader; distances cranes move (when they relocate)	Timing of hatch cover move- ments, timing of crane move- ments	Lighter-cycle/crane-cycle overlap (dictates synchron- ized watches)	Mean times for full cycle. Standard deviation, means for each of the five basic data elements.
	1. Different distances cargo moves during lift	Ship freeboard; hold number; deck level in hold; ship beam; obstructions to travel of lift beam. Does lighter reposition during operation?			
	2. Different visibility of operation to oper- ator of crane	Space available in lighter, or tentation of containers		Timing of approximate time lift disappears from view of operator of crane, and when it reappears (at lighter or hold of ship). Sample basis on both COD and TCDF.	For cases where crane operator must depend on sig- nals, percent of the time in each basic element that crane operator works "blind"
	3. Pendulation difference	Estimated feet of pendulation swing	Time for activating powered taglines when used	If separable, activities of tagline handlers; times for handling, installation and moving of tagging each cycle	

- The recorded test times are reasonable— that is, whether they at least roughly substantiate rates derived from planning factors.
- All major delays and their causes are recorded.
- The performance data on each system component is properly "tagged" with information on the numerical values of the important parameters that affect it.
- The system is in at least rough balance.
- The essential needs for statistical significance are met. (This requirement can be met by computer calculations of the dispersion of the averages of measured time data.)

To these ends, the following information should be available on a daily basis, with reports as of a to-be-specified cut-off time, as for example a time at end of the day shift. These reports should consist of information as shown in Tables 3.4, 3.5., and 3.6.

SPECIFYING QUANTITIES FOR REPETITIVE TESTS

Specifying the quantity of repetitions of test lifts is a judgmental decision. It is one that has been discussed in some detail in the LOTS Feasibility study.³ In the main, the judgment arrived at there (that throughputs of at least 600 container lifts for the crane-on-deck operations of the test and 600 more for the crane-on-barge operations) remain valid. Such a judgment is based partly on statistical reliability considerations, but the overriding need for the test program is to provide sufficient throughput to measure the system's capability for sustained effort. People and machines must be tasked in a way that includes test periods long enough to span initial learning improvement, fatigue effects, variations in the environment (e.g., wet and dry, night and day), and variations in physical circumstances (such as high or low tide, full or near-empty fuel tanks on certain lighters, and full or empty holds in

³ Operations Research, Inc., Feasibility and Definition of a Joint Logistics-Over-The-Shore (LOTS) Operational Test, ORI Technical Report No. 913, 30 April 1975.

TABLE 3.4
CUMULATIVE RECORD OF TEST RESULTS

SYSTEM THROUGHPUT OVERVIEW

	24 Hours Ending	Cumulative Over ____ Days of Test
Containers Moved off Ship	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>
Containers Cleared Through Beach	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>
Containers Received at Marshalling Area	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>
Containers Shipped from Marshalling Area	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>
	As of ____	
Containers Aboard Ship	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>	
Containers In Marshalling Area	<div style="border: 1px solid black; height: 15px; width: 80px; margin: 0 auto;"></div>	

TABLE 3.5
CONTAINER THROUGHPUT FOR PRINCIPAL SYSTEM COMPONENTS

CONTAINER MHE OPERATIONS - QUANTITIES AND RATES

TO FROM		LACV-30			LCM-8			LCU			LARC LX			CW Ferry			LARC XV			BC Barge ^{1/}		
		Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.
Ship Deck	Actual																					
	Target																					
Ship Hold	Actual																					
	Target																					

TO FROM		COD																		Rate ^{2/}		Std. Dev. ^{3/}	
		Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Quantity			
Ship Deck	Actual																						
	Target																						
Ship Hold	Actual																						
	Target																						

TO FROM		SHORE LINE OPNS																				
		Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.	Q	R	S.D.
Crane on Beach	Actual																					
	Target																					
Crane on El. C/W	Actual																					
	Target																					
Amphibian Crane	Actual				NA			NA						NA								
	Target																					
LACH	Actual	NA									NA						NA					
	Target																					

		IN			OUT		
		Q	R	S.D.	Q	R	S.D.
Front Loader	Actual						
	Target						
Side Loader	Actual						
	Target						
Marine Corps 30-ton Crane	Actual						
	Target						
LACH	Actual						
	Target						

1/ Possible Back-up

2/ This rate is containers per in-use hour.

3/ This is a cumulative standard deviation based on the average of all readings taken to date.

TABLE 3.6
RECOMMENDED CONTENT OF DAILY TEST RESULTS REPORT

FORWARD MOVEMENT OF CONTAINERS^{1/}

COMPONENT	Avg. Quantity in Use ^{2/}	Min./ Max.	Hours Moving Cargo	Hours Not Moving Cargo					
				Hatch Opening	Waiting for Lighter	Waiting for Transport Vehicles	Maint. Downtime	Moving Equip.	
								Number of Moves	Time per Move
SHIP CRANES									
COD						NA			
TCDF						NA			
Floating Crane						NA			
LIGHTERS									
LACV-30					NA	NA			
LCM-8					NA	NA			
LCU					NA	NA			
LARC LX					NA	NA			
CW Ferry					NA	NA			
LARC XV					NA	NA			
BC Barge					NA	NA			
SHORE TRANSFER									
6250 Crane				NA					
9125 Crane				NA					
Amphibian Crane				NA					
LACH				NA					
Front Loader				NA					
TRANSPORT TO MARSHALLING AREA									
Trans. Vehicles				NA	NA	NA			
MARSHALLING AREA									
Front Loader				NA	NA				
Side Loader				NA	NA				
30 Ton Crane				NA	NA				
LACH				NA	NA				

1/ A second data form, not shown, would repeat the above table for backloading.

2/ "In Use" here means moving cargo.

TABLE 3.6 (Cont.)

FORWARD MOVEMENT OF CONTAINERS (Cont.)

COMPONENT	Throughput Rates				Data Element ^{1/} Check											
	Avg. Contrs. per Total Operating Hr. (Inc. Hrs. Not Moving Cargo)	Avg. Contrs. per In-use Hour	Standard Deviation of Avg. Contrs. per In-use Hr.	Selected Highest per Hour Rate	A		B		C		D		E		F	
					Quantity of Readings	Avg. Time	Q.	Avg.	Q.	Avg.	Q.	Avg.	Q.	Avg.	Q.	Avg.
SHIP CRANES																
COD																
TCDF																
Floating Crane																
LIGHTERS																
LACV-30																
LCM-8																
LCU																
LARC LX																
CW Ferry																
LARC XV																
bc Barge																
SHORE TRANSFER																
6250 Crane																
9125 Crane																
Amphibian Crane																
LACH																
Front Loader																
TRANSPORT TO MARSHALLING AREA																
Trans. Vehicles																
MARSHALLING AREA																
Front Loader																
Side Loader																
30 Ton Crane																
LACH																

^{1/} These data elements are the six basic elements of cargo transfer discussed in Data Analysis section.

the ships). Deciding what is a sufficient number of repetitions to accomplish the above outlined goals must be based largely on remembered experience and intuition, rather than scientifically valid data (for which there have been only fragmented opportunities to collect in the relatively new and rapidly-changing art of handling commercial containers in a LOTS environment). The decision must be considered as a balance, where a very large amount of throughput (for example, 10 ship load) would be prohibitively and unnecessarily expensive, while small quantities (like 50 to 100 containers) would fail to support a sustained effort and would be statistically unreliable.

The statistical reliability of the tests has been discussed in detail in the LOTS Feasibility study. The discussion here does not repeat the analysis set forth there of possible statistical uncertainties in the measured times nor the estimated impacts of consequent errors in planning factors derived from the measured times. However, enough of the discussion in that report is summarized below to permit showing how additional information and some proposed improvements in techniques can impact on the test findings. These extensions do not change the previous estimates of statistical uncertainty but do further discuss the potentials for increases and decreases in it. The matters discussed include: (a) a revised assessment of the role of hatch cover removal and other "non-lift" time elements; (b) the use and analysis of time data more detailed than had been addressed in the previous report; and (c) use of techniques to reduce areas of statistical uncertainty.

The essence of the statistical accuracy of measurement discussed in the LOTS Feasibility study is summarized in these statements:

- Throughput rates for cranes, which usually control overall throughput rates, typically depend on times for both: (a) repetitive lifts and, (b) non-lift elements. The accuracy of throughput planning factors would seem to depend more strongly on (a) than (b), since on the order of four-fifths of the time of crane operations is estimated to be spent on (a), the repetitive lifts. Measurement uncertainties in (b), the remaining one-fifth of the time contributed

by such non-lifting activities as repositioning of cranes, adjustments to cargo gear, removing hatches, and the like⁴ thus have less weight and are likely to be less important to the final planning factor.

- The repetitive cycles are at once remarkably alike in that they consist of the same basic operations repeated time after time; yet the physical differences in reach and other factors from one cycle to another may be large. From the statistical viewpoint measurements of cycle times of the same operation in past tests have been so varied that substantial uncertainties in the final averages had to be accepted. (From the report on the OSDOC tests, for example, in discussing the differences among the rates for four cranes lifting the same cargo, the statement was made that "because of small sample size (i.e., smaller number of repetitions timed) differences of roughly 40 percent (between cranes) would have had to exist in order to be detected.")
- The amount of the uncertainty in the calculated average of a number of repetitive lift cycles decreases in inverse proportion to the square root of the number of lifts measured. For example, to decrease the uncertainty of a calculated mean to one-half its initial value, the number of lifts must be increased four times ($\frac{1}{\sqrt{4}} = \frac{1}{2}$). For the OSDOC tests the number of cycles measured for each condition averaged about 11, and the potential variation of the resulting mean values, at a 95 percent confidence level, was ± 20 percent. To cut this potential in half (i.e., decrease it from 20 to 10 percent, again at a 95 percent confidence

⁴ In this document the term "non-lift element" is used to distinguish actions that occur only once per several cargo lifts. These relatively seldom occurring activities may themselves be repetitive.

level) the number of cycles would have had to be increased fourfold, or to 44 cycles from the initial 11 cycles.

The preceeding facts and calculations are a quick summary of the material set forth in considerably more detail in the referenced LOTS Feasibility study. To these now may be added the further considerations that have come forward since the other was written:

- A refinement has been made to the concept outlined above of the relative importance of non-lift time elements to the overall planning factors.
- Some additional experience was acquired from the pretests in taking and analyzing more detailed time data within the cycle.
- A technique for analyzing detailed data elements will be used to decrease statistical uncertainty of the time averages of certain repetitive cycles.

Contribution of Non-Lift Time to Uncertainty

The planning factor uncertainty, as discussed above, depends on both the non-lift elements and the repetitive elements of the total time required for moving cargo. Both elements vary from situation to situation. The non-lift times, as mentioned before, for ship operations constitute on the order of one-fifth of the total time. Contrary to the previous assessment, however, this small fraction of the total time may possibly contribute a more than proportional share to the statistical uncertainty of the planning factor. This is because there will necessarily be fewer measurements made. Every effort must be made to record all elapsed times for these non-lift operations, in order to keep the uncertainty in the results from this source as small as possible.

Pretest Experience with Detailed Time Segments

The pretests increased the experience with timing techniques although they did not add significantly to the data available for analysis of throughput variability. There were not enough repetitions of the same operations to warrant changes in the previously made assessments of statistical variability. The

pretest timings included recording of detailed within-cycle times. At least one virtue of the detailed timing became apparent. Delays and interruptions would ordinarily have caused some overall data on full cycles to be thrown out. With the detailed timing procedure available timed parts of incomplete and interrupted cycles could, in effect, be recombined into new cycles for analysis. Thus, not so much data was unusable. Presumably, the use of the detailed timing in the main test will permit a greater fraction of the total data taken to be used (with consequent correspondingly small decreases in uncertainties).

Statistical Procedures

Various analytical and statistical techniques will be used in the analysis. Some will yield insights on the validity of certain comparisons. Others are expected to reduce statistical uncertainty somewhat by changing unexplained variability to explained variability, particularly within certain of the basic elements of the cargo transfer cycles discussed above. The reason for using the separate time elements rather than overall cycles is that the elements are more likely to be statistically relatable to physical measurements of the transfer cycle than the entire cycle would be. For example, it may be possible to relate time element D, move the load to numerical values of (a) the distance in feet the load is actually moved; and (b) certain measures of how fast the crane or boom can vertically move the load (e.g., the number of parts in the hoisting line). If in fact such relationships can be established, a part of the variability of the cycle is changed from simply being an unexplained variation to being an explained one, with a consequent reduction in uncertainty.

SPECIAL TEST RUNS FOR WEATHER-EFFECTS DATA

As discussed in some detail in the ORI report on the results of the breakbulk test⁵, analysis aimed at assessing the effects of sea state on LOTS operations presents difficult problems. Among them two aspects are particularly vexing for the LOTS main test analysis:

⁵ Operations Research, Inc., Report on Results of the Conventional Breakbulk Ship Pretest of the Joint Logistics-Over-The-Shore (LOTS) Test and Evaluation Program, ORI Technical Report No. 1037, 29 October 1976.

- a. All or most of the test will have to be conducted in whatever sea state happens to occur (rather than being a matter under experimental control) and
- b. There is a lack of knowledge concerning the mechanisms through which sea state phenomena affect the operations. That is, there is as yet no theoretical-practical framework on which an analysis of sea state effects can readily be based.

The first aspect must be accepted with its attendant uncertainty. The second appears to be a long-term problem and requires documented observations over more tests than are likely to be made in the next few years, together with the on-going theoretical work on platform motion and crane operations that is being pursued in the Navy COTS program. One possible step toward limited control of weather effects mentioned as the first aspect above, would be to move the site of vessel operations in response to weather. That is, if the sea state is high, record sample runs in the rough sea, then at a location in more protected water make sample runs there. If the sea is calm throughout the test, near its conclusion consider moving off-shore for sample runs (provided forecasts show suitable sea states off-shore).

Such a procedure may or may not prove necessary. Over the period of a 2-week test there is a substantial probability of weather changes either toward higher or lower sea states occurring so that the desired result might well be achieved without moving.

APPENDIX A

SERVICE TEST OBJECTIVES

GENERAL

Following publication of the LOTS Test Feasibility and Definition Study and early in the organization of the LOTS Joint Test Directorate (JTD), each of the participating Services presented a list of objectives which were then consolidated by the Joint Test Directorate. The objectives represented particular areas of interest the Services desired accomplished during the conduct of the pretests and main test. In some cases these objectives required particular efforts by the sponsoring Service that were in addition to the other activities to be performed in support of the LOTS test program. In some cases the objectives coincided with DDR&E objectives while in other cases they were strictly experimental and not within DDR&E guidelines for support of the test. In the latter case, especially, it must be understood that any experimentation outside the bounds of this test must be conducted on a not-to-interfere basis.

Service in-depth analysis of test results in the light of Service objectives included in the LOTS test will be possible from the data collected and objectively reported by the JTD. Service-peculiar tests relating to

mission changes in doctrine, R&D equipment, and other special trials may be separately accomplished during the LOTS main test so long as they do not detract from or degrade the capabilities of participating organizations.

It must be reemphasized that this is an operational—not a developmental—test. With respect to the Service test objectives contained in Table A.1, the Services may conduct as many pre-main test equipment and procedural check-outs as they desire and are encouraged to do so. In the main test LOTS units will deploy and operate with authorized equipment on hand using latest accepted and approved Service doctrine and procedures with a sense of urgency appropriate to an actual emergency situation.

TABLE A.1
SERVICE TEST OBJECTIVES AND COMMENTS

Service Objectives For The Joint LOTS Operational Test	Comments
<p>1. Assess the requisite planning for embarkation of AFOE and LOTS supplies, equipment and personnel in containerships and bargeships as well as breakbulk merchant ships. (Pretest/Main Test)</p> <p>1.1. Plan for acquisition of container (including refrigerated containers if required) and barge services at the locations where they would in reality have to be stuffed/loaded with materials. (Pretest/Main Test)</p> <p>1.2. Plan for accomplishment of container stuffing and barge loading operations. (Pretest/Main Test)</p> <p>1.3. Plan for movement of personnel, breakbulk cargo, containers and barges to the POE(s). (Pretest/Main Test)</p> <p>1.4. Plan for embarkation operation at the POE(s). (Pretest/Main Test)</p> <p>1.5. Determine requirements for equipment and procedures to provide an acceptable level of habitability for personnel embarked in AFOE or LOTS merchant shipping. (Pretest/Main Test)</p> <p>2. Assess the Services deployment capability of AFOE and LOTS equipment and procedures for introducing personnel and supporting equipment into an objective area. (Pretest/Main Test)</p> <p>2.1. Evaluate the deployment and off-loading of Army craft, materials handling equipment (MHE), and containers in a LOTS environment. (Pretest/Main Test)</p>	

TABLE A.1 (Cont.)

Service Objectives For The Joint LOTS Operational Test	Comments
<p>2.1.1. Determine realistic equipment preparation times. (Pretest/Main Test)</p> <p>2.1.2. Determine realistic equipment loading and off-loading times. (Pretest/Main Test)</p> <p>2.1.3. Determine equipment set-up time after off-loading. (Pretest/Main Test)</p> <p>2.2. Evaluate the deployment and off-loading of container over-the-shore (COTS)/amphibious logistics system (ALS) equipment in an AFOE environment. (Pretest/Main Test)</p> <p>2.2.1. Determine realistic equipment preparation times. (Pretest/Main Test)</p> <p>2.2.2. Determine realistic equipment loading and off-loading times. (Pretest/Main Test)</p> <p>2.2.3. Determine equipment set-up time after off-loading. (Pretest/Main Test)</p> <p>3. Assess the capability of the shipside subsystems to off-load and retrograde containers and discharge breakbulk cargo.</p> <p>3.1. Evaluate the sustained productivity and operation of a mobile crane-on-deck (COD) ship unloading subsystem, including engineering performance of deck strengthening and hatch cover bridging as well as crane fatigue performance. (Main Test)</p> <p>3.2. Evaluate the sustained productivity and operation of a temporary container discharge facility (TCDF); to include warping operations and hatch cover operations. (Main Test)</p> <p>3.3. Evaluate the effects of sustained operations for five or more consecutive days on COD and TCDF productivity and engineering performance of components. (Main Test)</p> <p>3.4. Evaluate the productivity and operational effects of devices to reduce container impact on ligherage for both the COD and TCDF modes. (Main Test/Limited Pretest)</p> <p>3.5. Evaluate the effects of a power tagline on COD and TCDF productivity. (Main Test/Limited Pretest)</p> <p>3.6. Evaluate the comparative productivity and manpower demands of COD and TCDF cranes using slings versus spreader bars for container movement. (Pretest)</p> <p>3.7. Evaluate the effects of environment, forces, and motions on COD and TCDF productivity. Obtain quantitative data through instrumentation. (Main Test/Limited Pretest)</p> <p>3.8. Exercise and evaluate bulk fuel ship-to-shore transfer capability in conjunction with a LOTS operation. (Main Test)</p>	<p>3.4. Standard dunnaging will be used as opposed to intermittent testing of special devices.</p> <p>3.5. Power taglines on COD-TCDF cranes will be evaluated on basis of normal operational use.</p>

TABLE A.1 (Cont.)

Service Objectives For The Joint LOTS Operational Test	Comments
<p>4. Assess the capability of various craft subsystems to move containers and breakbulk cargo ashore and to retrograde containers.</p> <p>4.1. Evaluate the capability and productivity of ferrying containers to shore via causeway barge-ferry, employing either the lift-on/drove-off or the lift-on/lift-off concept. (Main Test/Limited Pretest)</p> <p>4.2. Evaluate LASH barge discharge rates that can be sustained under sea conditions expected to be encountered in an AFOE or LOTS environment. (Pretest/Main Test)</p> <p>4.3. Evaluate procedures and practicability of initiating and terminating various modes of transfer operations for container and palletized cargo. (Main Test)</p> <p>4.4. Evaluate the sustained productivity of the LACV-30. (Main Test/Limited Pretest)</p> <p>4.5. Evaluate the sustained productivity and capability of the LCM. (Main Test)</p> <p>4.6. Evaluate the sustained productivity and capability of the LCU. (Main Test)</p> <p>4.7. Evaluate the sustained productivity and capability of the LARC-60. (Main Test)</p> <p>5. Assess the capability of shoreside subsystems to discharge lighterage.</p> <p>5.1. Evaluate the capability of Army container handling in terminal operations (CHITO) equipment to operate in a nonfixed port environment. (Main Test)</p> <p>5.2. (Marine) Evaluate fleet marine force (FMF) capability to remove containers from lighterage without benefit of a crane operated on an elevated causeway. (Main Test)</p> <p>5.3. Evaluate the sustained productivity and operation of an elevated causeway shoreside discharge facility. (Main Test)</p> <p>6. Assess the capability of shore transport equipment and shoreside beach improvements required to handle containers and breakbulk cargo.</p> <p>6.1. Evaluate the capability of the 34-ton trailer. (Main Test)</p> <p>6.2. Evaluate the capability of the hydraulic fifth wheel yard tractor. (Main Test)</p> <p>6.3. Evaluate the capability of the 22½-ton breakbulk/container transporter. (Pretest/Main Test)</p> <p>6.4. Evaluate beach surfacing methods and techniques. (Main Test/Limited Pretest)</p> <p>6.5. Evaluate the time required for shoreside improvements necessary to allow container operations. (Main Test)</p> <p>6.6. Evaluate the operational effectiveness of lighting, auxiliary power, and communications equipment employed in the LOTS operation. (Pretest/Main Test)</p>	

TABLE A.1 (Cont.)

Service Objectives For The Joint LOTS Operational Test	Comments
<p>6.7. (Marine) Evaluate selected items of commercial container handling equipment which may be suitable (without major modification) for use in a logistics support area (LSA) environment. (Main Test)</p> <p>5.8. Evaluate FMF equipment (programmed as well as existing) capable of handling/transporting 20-foot containers ashore. (Main Test)</p> <p>7. Evaluate operational equipment and procedures for ship anchoring, fendering, and ship handling during container discharge operations. (Pretest/Main Test)</p> <p>3. Test and evaluate tethered balloon discharge concepts in LOTS operation. (Pretest)</p> <p>9. Assess container breakbulk cargo management concepts and procedures.</p> <p>9.1. Evaluate container accountability procedures. (Pretest/Main Test)</p> <p>9.2. Evaluate effectiveness of the container/cnassis remote scanner. (Pretest/Main Test)</p> <p>9.3. Evaluate the total system concept for cargo documentation procedures, including the use of automated equipment, from (exercise) shipper to (exercise) consignee. (LSA and DSSA) (Main Test/Limited Pretest)</p> <p>9.4. Evaluate the capability to exercise control over cargo movement from ship to logistics support area to permit the expeditious identification and location of both containers and breakbulk cargo. (Main Test/Limited Pretest)</p> <p>10. Evaluate operating procedures for support of Service land forces from container and barge ships in an AFCE/LOTS environment.</p> <p>10.1. Evaluate the Service organizations' capability to discharge, transfer, and handle cargo on the beach. (Main Test/Limited Pretest)</p> <p>10.2. Evaluate the Service organizations' capability to construct facilities and prepare beaches for AFCE/LOTS operations. (Main Test/Limited Pretest)</p> <p>11. Assess the Services capabilities to provide command and control for AFCE/LOTS operations.</p> <p>11.1. Evaluate Navy command and control procedures involved in AFCE operations. (Pretest/Main Test)</p> <p>11.2. Evaluate the ability of the Services to transition from a Marine/Naval AFCE beach to an Army LOTS operation. (Main Test)</p> <p>11.3. Evaluate the capability of the Army terminal battalion headquarters to manage and control the deployment/discharge operation. (Pretest/Main Test)</p>	<p>6.7. The general comment "...selected items of commercial...equipment..." is so general as to permit the introduction of a number of candidate items for comparison for future selection and procurement. Only those items will be permitted which have at least been tentatively selected for procurement and will be used throughout the exercise for evaluation purposes.</p> <p>8. Not applicable.</p> <p>9.2. Continued service testing of this device must not interfere with the test and evaluation of the units current documentation and cargo management systems.</p>

APPENDIX B

SCENARIOS

NON-MOBILIZATION AND MOBILIZATION SCENARIOS¹

A U.S. alliance is being threatened by a politically unstable situation in which Crystal, a friendly, underdeveloped coastal nation is being threatened by its neighbor, Mountain. Radical Mountain leaders hope to use a wartime military emergency to consolidate their political gains in the Mountain government and expand their financial resources and power base through the acquisition of Crystal. Crystal has requested military assistance and its economic, strategic, and political interests are considered vital to the U.S. The President of the U.S. with the support of Congress has alerted the Joint Chiefs of Staff to prepare a task force for assistance to Crystal and to deter Mountain from invasion. Reliable intelligence estimates have indicated that a strong U.S. presence in Crystal for approximately six months would discourage hostilities and greatly assist the military forces of Crystal in halting the infiltration of saboteurs. Congress has stipulated that total withdrawal must be completed by that time.

JCS establishes a joint command (see Figure B.1) and forces are nominated for support of the operation. The army has been tasked with the responsibility of providing terminal service operations for breakbulk and containerized

¹ Scenarios for evaluation of force structure and equipment requirements will be published in a separate, classified, annex.

cargo. The Navy has been tasked with providing sufficient Military Sealift Command (MSC) breakbulk shipping of a conventional and heavy-lift nature to support the deployment of the seatail and the Air Force has been tasked with providing limited aircraft assets for movement of the advance party and necessary units to conduct early engineering and beach preparations.

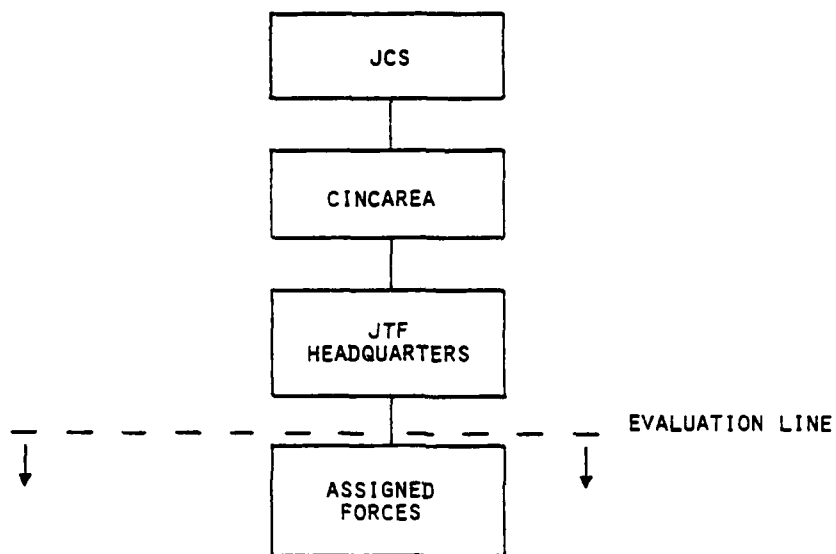


FIGURE B.1. JOINT COMMAND STRUCTURE

Major General Alton G. Post, Commanding General U.S. Army Transportation Center, as Joint Test Director will serve as CINCPAC and designate the JTF Commander. The JTF Commander will organize the JTF staff with personnel provided by the Services. For operations in Crystal the JTF comes under operational control of CINCPAC upon arrival. CINCPAC will provide support as necessary.

The non-mobilization situation involves quick-reaction forces deployed in response to a request for assistance to this underdeveloped country. Although the friendly government is threatened by an aggressive neighboring country, deploying airborne and seaborne forces from the U.S. will arrive unopposed. Mountain air and sea forces do not pose a significant threat to the subsequent LOTS operations.

The host nation has only a minor seaport with inadequate wharfage and insufficient water depth alongside to accommodate ocean going vessels. The existing port facilities are already overtaxed with coastal and inland waterway craft handling badly needed cargo to support the local economy and Crystal military forces. U.S. forces initially will be dependent on an air line of communications until a surface supply line is established employing Logistics-Over-The-Shore (LOTS) operations.

In view of the short lead time between the receipt of a request for assistance and the U.S. decision to respond, ocean shipping available for deployment of LOTS units to meet required on-berth dates is limited to the assets of the Military Sealift Command augmented by a few tramp breakbulk and opportune specialized vessels. For the purposes of this exercise a heavy-lift breakbulk vessel, a containership, and a LASH bargeship will be used for deploying selected elements of the LOTS force along with delivering breakbulk and containerized resupply cargo.

The Joint LOTS main test plan commences with the alert of participating units and the assembly of a Joint Task Force command element at Ft. Eustis, Virginia. Units are brought to a high state of readiness and prepare to deploy to aerial and sea POEs on order.

Seventy-two hours after receipt of the warning order (D-3), orders are received to execute the operation plan (D-Day). Advance parties of the JTF headquarters and major operating units depart by air for the objective area on D+4 and D+5. (Movement by air will be simulated. Advance parties will move by highway to Ft. Story, perform site selection, and begin establishment of an operating base).

Ten days later (D+15) the main party begins to deploy by air with minimum essential equipment to prepare the beach sites, routes to and from an assembly area, etc. (Although all such equipment will be moved by surface means, each item will be documented indicating full nomenclature, and dimensions and how deployed; e.g., tractor, FTRAC, D7 with dozer blades, 168 in. x 83 in. x 61 in., 36,805 lb, 492.2 cu, deployed by C141 or C5.)

Five days after receipt of movement orders (D+7), the simulated JTF seatail echelons depart for loading at waterports of embarkation. Selected

LOTS outsize, heavy equipment will be loaded on a heavy-lift breakbulk ship. The balance of the unit TOE and accompanying supplies will move by surface means to the operating area. Again, all major equipment items will be documented. Data must be obtained for later evaluation to determine the amount of shipping that is required to deploy these units.

The advance parties, main bodies—both air and seatail—must deploy early enough during the exercise to insure that the beach is fully operational before the non-self-sustaining ship is standing off-shore. Backward planning from that date is required to determine the start of beach preparation and the latest date the heavy-lift breakbulk ship is to commence out-loading operations at NSC.

An illustrative main test schedule for the non-mobilization scenario is contained in Figure B.2.)

POL will be provided by tanker trucks. Ship-to-shore bulk POL re-supply operations will not be played.

MOBILIZATION SCENARIO

General Situation

Following World War II the expansionist policies of Orange threatened the takeover of the neighboring democratic government of Blueland, gravely weakened by the war. In response to requests for assistance, the U.S. provided massive aid for the economic recovery of Blueland. Military assistance was also provided to counter the threat of a revolt instigated by Orange sympathizers.

An outgrowth of negotiations between the U.S. and Blueland was a mutual assistance treaty in which the U.S. pledged to come to the immediate aid of Blueland in the event of an attack by any other nation(s). The treaty was subsequently ratified by the Senate. Since that time the Blueland economy has enjoyed a rapid recovery and the country has become a close trading partner with the Western World. Imports of certain ores and bulk petroleum from Blueland are particularly important to the U.S.

Until the U.S. intervention in the Crystal-Mountain crisis, the U.S. and Orange have successfully negotiated agreements concerning sporadic Orange-

Blueland border incidents. Following that intervention, however, tensions between the U.S. and Orange have mounted sharply.

While the U.S. continued to press for a peaceful settlement of the dispute, Orange recalled its Ambassador from Washington, and began mobilizing its military forces. Blueland called up its Reserves and manned defensive positions along the Orange border.

In view of the failure of diplomatic approaches for talks with Orange leaders and intelligence reports that Orange may attack at any moment, the President of the U.S. placed U.S. military forces on alert. A request for Congressional approval for the call up of selected National Guard and Reserve units was also being staffed.

At 0500 hours, D-Day, Orange forces launched an attack on Blueland along a broad front. The attack occurred while the last of the deploying units closed in Crystal. Blueland border units were able to slow and contain the attack except near Blue Haven. There, enemy artillery heavily damaged port facilities during their use for at least three months.

In response to a request for assistance and the possibility of outbreak of hostilities in other areas of the world, the U.S. began to mobilize its forces and to dispatch troops to Blueland. U.S. Navy and Marine Corps units were alerted for movement to Blue Haven as soon as possible and to secure a beach head, if necessary, by amphibious assault. In Crystal where the port congestion problem was brought under control, U.S. Army LOTS units were alerted for redeployment to Blueland.²

The military situation in the south sector of Blueland continued to worsen (see situation map, Figure B.3) and on D+40 the U.S. Navy with embarked MAF launched an amphibious assault over Green and adjacent Red and Blue Beaches. Enemy advance units were caught by surprise and driven back to the White River. The Marines off-loaded their assault echelon equipment and supplies. During this period Navy units erected an elevated causeway.

² In this scenario due to the emergency powers of the President, ship availability will not be a limiting factor for test purposes. Total ship requirements will be determined in the evaluation following completion of the test.

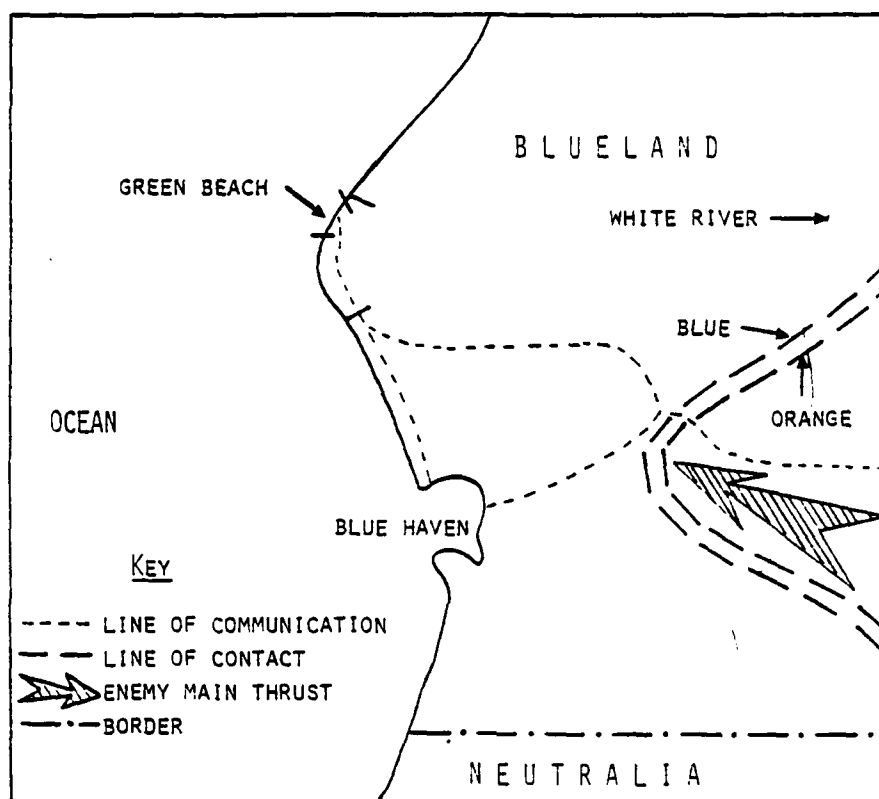


FIGURE B. 3 SITUATION MAP ON D+40

Improved Beach Operations

By D+50 the military situation in the south sector has improved and the enemy threat to the beach area operations is minimal. The Navy/USMC beach operation, augmented by arriving U.S. Army lighterage units, is handling all general cargoes over Green Beach.

As major U.S. Army combat elements begin to arrive, it becomes apparent that the LOTS capability at Green Beach must be expanded. Also, with planned shift in support to a predominately Army combat force, CINCUSWEST has requested the U.S. Army augment the USN/USMC over-the-shore operation and be prepared to assume responsibility for the joint LOTS operation by D+60. Army elements are attached to the JTF with advance parties arriving on D+51. (The Chain of Command is depicted in Figure B.4.)

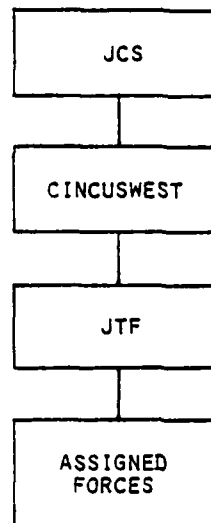


FIGURE B.4. CHAIN OF COMMAND

On D+61 the USN/USMC throughput and retrograde operations are completed and the transition is made to an Army managed joint LOTS operation consisting of both Army and Navy support units. With regard to the improved beach cargo handling facilities, the JTF commander has requested retention of all Service assets for use during the duration of the joint LOTS mission. (During this final phase of joint LOTS test operations, attempts will be made to determine the maximum throughput rate of the improved beach shore container handling subsystems. To tax the throughput capability of both the elevated causeway and the DeLong pier will require the employment of a third crane at the containership.)

With vessels of all types being used to meet U.S. movement requirements, the LOTS commander is confronted with the requirement of handling barge delivered cargo (pallets, vehicles, containers) concurrently with containers from containerships. Both the Navy and Army systems are having to accommodate to these diverse ship delivery systems.

As a support element of the JTF, a communications unit is available for handling logistic data requirements including MILSTAMP traffic. The LOTS mobile Standard Port System (SPS) van is provided with a communications link to the computer at the logistics base established in Blue Haven by elements of the 1st Support Command. (These elements, including the SPS unit, have been providing cargo documentation and movement control support throughout the exercise.

APPENDIX C
SHORESIDE CARGO TRANSFER PROBLEMS, BARE BEACH

This appendix provides a partly quantitative review of the physical problems encountered during cargo transfer operations from lighters at the water's edge. The problems are those expected to be encountered at the LOTS test site at Ft. Story, Virginia, but comments are also made concerning the problems at beaches in general. Given time and material to construct facilities and clear channels, the problems discussed can be alleviated. This appendix discusses the problems that are faced in a "bare beach" operation during a period before major improvements can be installed, such as piers elevated above the surf. The appendix includes a brief discussion of the crane platforms currently available that could be considered for the period of bare beach operations.

The primary problem is that cargo transfer from landing craft at the water's edge is hindered by water depth. The problem is made worse by tide changes and waves, yet the transfer must take place close to shore. Amphibian lighters permit the transfer to be made ashore out of reach of surf, but current amphibians are generally unsatisfactory from the point of view of availability and have limited cargo/container capacity. Causeway ferries provide an appropriate capability but have freeboard limitations and, like amphibians, are in short supply.

There appears to be no fully satisfactory solution to the problems outlined in this appendix. All available alternatives appear to be time-consuming during the phase of LOTS operations when urgency is important. Additionally, most require considerable strengthening, some modification, and present deployment and assembly problems.

DISTANCE BETWEEN THE WATER'S EDGE AND THE LANDING CRAFT

Landing craft "ground out" in approximately 4 ft of water when at full load displacement and in somewhat less water when loaded with containers.¹ The calculations shown hereafter arbitrarily assume that operationally the landing craft of concern (LCUs and LCM8s) can operate in $3\frac{1}{2}$ ft. If the near-shore underwater profile of the beach is steep, the landing craft can come in close to shore, even with a $3\frac{1}{2}$ -ft draft. Containers or other cargo can be lifted off using a crane operating from dry land with a reasonably short reach. At a steep beach vehicle cargo can be driven off the landing craft ramp dry or without having the vehicle wade in unduly deep water. Unfortunately, beaches steep enough to do these things appear to be an exception rather than the rule.

One way of quantifying beach steepness or flatness is in terms of an average slope to seaward of the low-water mark. Actual beaches have slopes that vary somewhat from their own average and usually include sandbars. However, the concept of an average slope within the limited zone between the low water mark and a depth of about 4 ft has proven useful. For instance, an average slope of 2 percent is typical of Ft. Story. For such a slope the water depth increases 2 ft for every 100 ft moved out from the low water mark. Note that the slope is steeper on the beach exposed between high and low water. Thus, a $3\frac{1}{2}$ ft depth occurs 175 ft from the water's edge. It is not feasible for a crane to reach that far out from shore. Most beaches are even flatter. As indicated in Section II, page 2-31 of this study on site selection, 81 percent of beaches in various strategically important areas of the world had slopes less than a ratio of 1 to 61 or 1.64 percent.

¹ It would be desirable to have available formally collected and documented data on the operational depth for grounded landing craft, taking into account the effects of different displacements, the slope of the bottom, the assistance of surf in riding further toward shore. Such data are not available, to the knowledge of the authors.

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COMMENT DRAFT REPORT ON MAIN TEST DESIGN OF THE JOINT
LOGISTICS-OVER-THE- (U) OPERATIONS RESEARCH INC SILVER
SPRING MD H CASEY ET AL. 30 JAN 77 ORI-TR-1132
MDA903-75-C-0016

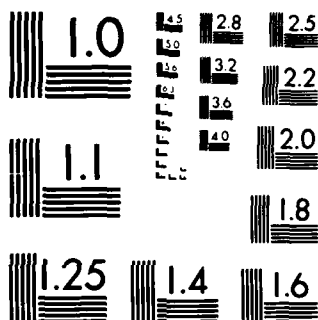
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

The impact of a flat beach slope on the horizontal distances involved is worsened by tidal changes and waves. The mean tide difference at Ft. Story is 3.2 ft. The corresponding horizontal distance in the steep part of the beach between high and low water averages approximately 50 ft at Green Beach, Ft. Story, according to the available surveys. This means that the total horizontal distance from the high water mark to the place where the depth is $3\frac{1}{2}$ ft at low water is 175 ft plus 50 ft, or 225 ft. This is an approximate minimum figure for round-the-clock operations at the parts of Ft. Story beach where the slope is 2 percent. For planning purposes the data may be used as follows. On available surveys of Green Beach sketch in a contour for $3\frac{1}{2}$ -ft depth. Scale off its distance from the high water mark. The distance averages 210 ft and varies between 150 ft and 300 ft. The resulting figure could be used when considering the combined reach of a crane and any pier or platform extending out from the high water mark.

This minimum does not yet include an allowance for the distance within the craft between the cargo location and the point where the craft grounds out. The grounding point is usually 10 to 20 ft aft of the bow, but the distance depends on the location and size of the load. It also depends on the underwater slope and even on the wave height, since landing craft can sometimes make use of the temporary buoyance from swells to move in somewhat closer. No attempt is made here to take these diverse matters into exact numerical account, but an allowance for reaching the load in the lighter above the minimum must be considered. For LCM8 operations the allowance ought to be in the neighborhood of 25 ft and for LCUs around 75 ft. For the 2 percent beach slope example a round figure would be to increase the minimum "reach" of whatever platform and crane combination is being contemplated to 250 or 300 ft from the high water mark.

EFFECTS OF SURF

In an operation in surf, a crane platform would be subject to wave forces that tend to move it. Breaking waves can impact on structures with very sizable dynamic forces. For grounded landing craft there is a tendency to turn (i.e., broach), and any platform considered would presumably have similar tendencies. To resist these forces requires some provision for

anchoring to the bottom, securing with pilings and/or lines to the shore. Anchors and guys to shore are least satisfactory because of the looseness of a sand beach.

In the surf zone along beaches there is a transport of sand that also must be considered. It comes about from the angle the waves make with the beach. As can be seen in resort areas where groins are set up to slow or change this transport, the up-current side of an obstruction impounds sand against a dam. There is a loss of sand ("starvation") on the downstream side and possibly under the structure. The net effect is a possible unsymmetrical buildup of sand over a period of time. The sand foundation may cut away from under the downstream side causing the platform to tilt. This change in the sand is a potential threat to the operational use of a platform that is grounded in the surf. The threat is difficult to evaluate, partly because it depends on the wave size encountered in the operating period. The time needed for a serious change of sand foundation depends not only on wave size and direction, but also on the local tidal current. Informal estimates made at the Corps of Engineers Coastal Engineering Research Center at Ft. Belvoir are that waves about 2½ feet high would begin to affect the operation of a grounded barge in the surf in as little time as one day.

LIMITATIONS ON CRANE PLATFORMS

The above paragraphs outline the requirements on the reach for the combination of a crane and its platform. Other important requirements include:

- Being capable of supporting the operating crane (including hoisted load) and
- Providing a facility to permit moving the cargo lifted out of the lighter by the crane (e.g., a ramp, causeway, or bridge connected to the shore).

Both of these fundamental requirements are highly dependent on the particular pier or platform being considered. This appendix will not elaborate on the second of the above, except to say that in addition to moving the cargo ashore it may be desirable or even mandatory to be able to move the crane itself off the platform to safety ashore in the event of a storm. The deployment and installation of bridge sections heavy enough to support repositioning the crane may be especially difficult.

The first requirement, that the platform be able to support the operating crane, has two subheadings: a) it must be strong enough to transmit the stresses involved to the sea or to the bottom, and b) it must resist tipping or capsizing as the crane operates.

ALTERNATIVE CRANE PLATFORMS FOR BARE BEACH OPERATIONS

This section gives an outline description of a number of possible candidates for the role of providing a temporary platform for transferring cargo at the water's edge, together with the principal considerations affecting their use. More complete information, including stress analysis calculations for several of the candidates, are available in ORI files.

Grounded BC Barges With Ramps

Description. BC barges that have been ballasted down by flooding provide a pier on which a crane can operate. Two barges, for example, separated by a bridge made from DeLong ramps and joined to the shoreline with another ramp would bring the crane operating section into water deep enough for unloading landing craft at Ft. Story.

Clearance of Cargo. Cargo removed from landing craft is carried away by truck or frontend loaders.

Deployment. BC barges can be deployed by heavy-lift breakbulk ships and by SEABEE barge ships.

Positioning and Assembly. Barges can be positioned at high tide with landing craft used as tow boats and can also be moved in shallow water by bulldozers. Assembly of ramps requires careful positioning of crane and planning of operational sequence.

Strength. For crane movements on barge decks the barge needs steel trackage to spread the concentrated wheel loads. Some internal strengthening is also required. Ramp strengthening is needed too. Problems of barge strength when the sea bottom is not flat need investigation, especially with the use of bridge-ramps.

Availability. Some 45 BC barges are in the Army inventory.

Other Requirements. Provision must be made for flooding and for pumping out.

Grounded Causeways

Description. Double-width causeway sections (i.e., 6 pontoons wide x 15 long) are joined end to end and flooded down to form a pier. AMMI pontoons, a Navy experimental design, could also be considered for employment.

Clearance of Cargo. Trucks must back on or off unless a turnaround facility is also provided.

Deployment. A breakbulk ship with a 60-ton boom was shown in pre-tests to be able to carry a single 92-ft section. Possibly a second might be placed on top of the first. LASH, SEABEE, and heavy-lift breakbulk ships can also carry causeway sections.

Positioning and Assembly. Positioning could be done readily before flooding. Fastening the pairs of causeways side-by-side can be done in sheltered water by a method described in the Navy pontoon handbook.² In even a moderate seaway this assembly would be difficult.

Strength. The causeway would require wood or steel deck runways to spread the loads of both cranes with counterweights. Special pads for outriggers are also required.

Availability. Pontoon sections are in short supply with the operating Navy Forces. Some Reserve stocks reported as stored in CONUS and England and surplus AMMI pontoons may possibly be used as a substitute item.

Other Limitations. Flooding down requires removing plates that are difficult to get at. There is no provision for pumping out to recover sections after use. In operation, the 5-ft height of a Navy pontoon means that when the pontoon pier is in water 4 to 5 ft deep waves will wash over the deck.

² Department of the Navy, Naval Facilities Engineering Command, Pontoon Gear Handbook Navy Lightered (N.L.) Equipment P-Series, NAVFAC P-4-1, November 1974.

Expedient Piers or Docks

Description. Local facilities can be constructed that use sand constrained by pilings or empty containers. Such facilities would extend a crane base out into water deep enough for landing craft operations. Dredging may be used as an alternative to building the pier all the way out to the deep water.

Clearance of Cargo. Trucks or materials handling equipment would operate on sand ramp, matting, or planks.

Deployment. Empty containers, pilings, and other required materials can be deployed on all ships considered by LOTS operations.

Positioning and Assembly. Piles require driving. Empty containers could be positioned, then filled with sand if most of their tops are removed.

Strength. Piles are strong enough but the action of waves can quickly wash away support (as it did during OSDOC II operations). Empty containers are too weak to withstand the side pressures of sand within them if any significant load is placed on top of the sand.

Availability. This was not investigated in detail, but availability does not appear to present any difficulty.

Other Requirements or Problems. A pier extending far enough into the water for round-the-clock operations at Ft. Story appears impractical because of time required, expense, and vulnerability to wave action. A dredged channel with a built-up side as a platform for a crane appears to have the same problems. The possibility of using expedient breakwaters to cut down surf action has been suggested. Those using discarded tires appear cheap and effective.

CONCLUSIONS

The basic problem of unloading containers from landing craft at all tides during a bare beach operation, using a crane on the beach with only equipment and materials readily deployable and available to the Army generally remains unresolved. The P&H 6250 crane positioned on a sand ramp in the Joint LOTS test will be able to reach containers in landing craft only during a relatively narrow window of time and at near high tide. That operating time

period is planned to be widened by dredging (in lieu of explosives) and by increased use of amphibian vehicles.

The Navy floating causeway and the Marine Corps Light Amphibious Container Handler (LACH) which can wade in the surf while unloading landing craft will also be tested and evaluated as alternative means for handling containers over beaches with flat gradients.

APPENDIX D

INTERIM RESULTS OF LOGISTICS-OVER-THE-SHORE SIMULATIONS

INTRODUCTION

This appendix presents a summary of the interim results of the Logistics-Over-The-Shore (LOTS) simulation model. The purpose of the model runs discussed is to validate and refine test concepts, resource requirements, timings, and operational procedures for the Joint LOTS Operational Test.

A series of computer runs was made to provide a sensitivity analysis of the bare beach operations and of the improved beach for amphibious forces phases of the main test. Parameters, such as the lighterage mix and speeds, distance of the containership from the shore, etc., were varied. The planning factor for container throughput is 300 containers for a 20-hr operational day. The simulation model was used to compute the time to discharge 300 containers from the ship.

In using the model for the analyses, the total time for unloading the cargo and moving it ashore to a marshalling area was the principal model output. It should be noted, though, that the minimum time for unloading when the system is in balance is, in fact, the direct result of the input selection. That is, when the ship unloading rate is specified, the minimum time for moving the cargo ashore is the time for all the cargo to move out of the ship plus the time it takes the last piece of cargo to move from the ship to the marshalling area.

If there is any time spent waiting for lighters the total time increases. Thus, in the runs to be discussed, the model was usually used starting with too few assets, which resulted in a greater than minimum time. Then in each succeeding run the assets were augmented until the predictable minimum time was achieved. Any further increase in assets, of course, could not reduce the minimum time. Note also that the model is an "expected value model" that does not take into account the variability of rates.

Performance characteristics of LOTS system equipment are input to the model. Table D.1 shows the data used for lighter speeds, capacities, and for mooring and unmooring times. The assumed container transfer times at the ship (where two cranes were modeled), at the shore, and at the marshalling area are in Table D.2.

TABLE D.1
LIGHTER CHARACTERISTICS

Lighter	Nominal Speed (knots)		Container Capacity	Mooring Time (min)	Unmooring Time (min)
	Empty	Loaded			
Causeway Ferry	5	3	12 ¹	5	2
LACV-30	50 ²	42 ²	2 ³	1	1
LARC-LX	6.6 ⁴	6.2 ⁴	1	2	2
LCM8	11	9	1	2	2
LCU	8	6.5	4	5	2

¹Four section causeway ferry.
²The speed of the LACV-30 on land is taken as 30 mph.
³The LACV-30 can carry two containers not to exceed 30 short tons with 2 hr of fuel.
⁴The speed of the LARC-LX on land is taken as 15 mph when empty and 14 mph when loaded.

TABLE D.2
CONTAINER TRANSFER TIME

Location	Cycle Time (min)
Ship	5*
Shoreside	
Crane-on-beach	5
Crane Inland (used for amphibians)	3.5
Elevated Causeway	4
LACH	10
Marshalling Area	3

* Five minutes is used for both the crane-on-deck and the temporary container discharge facility.

BARE BEACH OPERATIONS

For the bare beach phase, two LOTS crane elements were modeled for the unloading of containers from lighters: the crane-on-beach for unloading landing craft and an inland crane for unloading amphibians. Both cranes were assumed to operate full time. The lighters available for this phase of the test are two LACV-30s, four LARC-LXs, and at least 19 LCM8s. One LACV-30 and three LARC-LXs are assumed to be available for a full day of container operations, leaving one of each available as a backup. A separate set of runs was made substituting LCUs for LCM8s.

A series of computer runs were made to determine the number of lighters and the time required to discharge the 300 containers from the ship in the bare beach operation. The lighter mix consisted of amphibians and landing craft. Since the number of amphibians is limited, they were held constant at one LACV-30 and three LARC-LXs. At 1 nmi the number of LCM8s was varied and the time to discharge the ship was computed. The results of these runs are shown at the top of Table D.3. The results show that a minimum time of 17.5 hr was reached when the number of LCM8s was increased to six; adding more LCM8s could not decrease this time. The LOTS system in this case was in near equilibrium with four amphibians being discharged at the inland crane and six landing craft at the crane on the beach.

TABLE D.3
TIME TO DISCHARGE 300 CONTAINERS IN THE BARE BEACH OPERATION
USING LCM8s IN THE LIGHTER MIX

Lighters			Distance of Ship Off-Shore (nmi)	Lighter Speed	Time to Discharge 300 Containers (hr)
LACV-30	LARC-LX	LCM8			
1	3	4	1	Nominal	18.9
1	3	6	1	Nominal	17.5
1	3	7	1	Nominal	17.5
1	3	12	3.3	Nominal	19.9
1	3	16	3.3	Nominal	19.4
1	3	17	3.3	Nominal	19.4
1	3	12	3.3	Reduced	21.2
1	3	16	3.3	Reduced	20.2

Another series of runs was made to estimate the effect of increasing ship-to-shore distance to 3.3 nmi. The results of these runs are shown in Table D.3. The minimum time to discharge the ship was 19.4 hr which was reached when the number of LCM8s had been increased to 6; the total time increased to 19.9 hr when 12 LCM8s were tried. In general, increasing the distance from 1 nmi to 3.3 nmi increased the minimum time to discharge the ship from 17.5 hr to 19.4 hr, about 2 hr. The number of LCM8s had to be increased significantly— from 4 to 16— in order to keep the cranes on ship busy. In this case, the system was getting out of balance as the proportion of containers moving to the two shoreside cranes was changing. The minimum of about 17½ hr cannot be achieved because the number of amphibians is fixed.

Additional runs were made to determine the effects of changes in lighter speeds on lighterage requirements. Slightly reduced lighter speeds may occur in the main test because of winds and currents and operating conditions may limit the speed of amphibians. The assumed speed of the LCM8 was reduced 2 knots. The sea speeds of the amphibians remained the same but the land speeds were decreased. The speed on land of the LACV-30 was reduced to 15 mph and the LARC-LX to 10 mph. At 1 nmi the computed time to discharge 300 containers was 21.2 hr as compared to 19.9 hr for lighters operating at their normal speed. In general the total time to discharge and move 300 containers through the system was not very sensitive to the above reductions in lighter speeds, and therefore did not require an adjustment in lighter resources.

Next a set of runs was made using LCUs in place of LCM8s in the lighter mix. At 1 nmi off-shore a minimum time of 18.3 hr to discharge the ship was computed when four LCUs were used in place of six LCM8s. Again, to find the effect of increasing the ship-to-shore distance, the ship was simulated as being 3.3 nmi off-shore. A minimum time of 19.9 hr was achieved when the number of LCUs was increased to eight. The time to discharge the ship with a given number of LCUs is presented in Table D.4. Again, increasing the ship-to-shore distance required an increased number of lighters. The total time to complete the discharge of the 300 containers did not significantly increase.

TABLE D.4
TIME TO DISCHARGE 300 CONTAINERS IN THE BARE BEACH OPERATION
USING LCUs IN THE LIGHTER MIX

Lighters			Distance of Ship Off-Shore (nmi)	Time to Discharge 300 Containers (hr)
LACV-30	LARC-LX	LCU		
1	3	0	1	33.8
1	3	2	1	21.3
1	3	4	1	18.3
1	3	6	1	18.3
1	3	2	3.3	29.5
1	3	4	3.3	22.8
1	3	6	3.3	20.4
1	3	8	3.3	19.9
1	3	10	3.3	19.9

An analysis was made of the last run with four LCUs and the ship 1 nmi off-shore to illustrate the computed number of lighter cycles in a 20-hr operational day. A lighter cycle is considered to be a roundtrip from the ship to the shore. The number of cycles for the LACV-30, the LARC-LXs, and the LCUs are shown in Table D.5. The assumed number of containers carried by each is given in Table D.1. Some partially loaded lighters, however, are anticipated. For example, lighters depart the ship when a hatch is empty even if they are not completely loaded. If two containers exceed the weight capacity of the LACV-30, it would travel to the beach with only one container. Both of these events occurred in the above computer run. This is why the expected number of containers (314) as shown in Table D.5, carried by the lighters exceed the actual number of containers (300).

TABLE D.5
NUMBER OF LIGHTER CYCLES

Lighter	Number of Cycles For Each Lighter	Expected Number of Containers Moved by Each Lighter
LACV	33	66
LARC-LX	20	20
LARC-LX	20	20
LARC-LX	20	20
LCU	12	48
LCU	12	48
LCU	12	48
LCU	11	44
TOTAL		314

In summary, for a containership located 1 nmi off-shore, it would require at least one LACV-30, three LARC-LXs and six LCM8s to discharge 300 containers in the minimum time. For a ship 3.3 nmi off-shore it would require at least one LACV-30, three LARC-LXs, and 12 LCM8s to discharge the 300 containers. The above estimates do not include lighters required in the event of breakdowns or for maintenance. One LACV-30, one LARC-LX and several LCM8s are available as back-up.

IMPROVED BEACH FOR AMPHIBIOUS FORCES

In the improved beach for amphibious forces phase of the main test the elevated causeway and the light-weight amphibious container handler (LACH) were modeled as system elements to off-load containers from lighters at the beach. As before, two cranes were modeled for off-loading the containership with a planned goal of 300 containers per day. One causeway ferry and two LCM8s were held fixed and the number of LCUs was varied in order to achieve a minimum throughput time.

As seen in Table D.6 in the first run the ship was 1 nmi off-shore and the lighter mix consisted of one causeway ferry and two LCM8s and 1 LCU. In subsequent runs the number of LCUs was increased. A minimum time of 18.7 hr was computed to discharge the ship when the number of LCUs was increased to seven.

TABLE D.6
TIME TO DISCHARGE 300 CONTAINERS IN IMPROVED BEACH FOR
AMPHIBIOUS FORCES PHASE OF THE MAIN TEST

Lighters			Distance of Ship Off-Shore (nmi)	Lighter Speed	Time to Discharge 300 Containers (hr)
Causeway Ferry*	LCM8	LCU			
1	2	1	1	Nominal	27.7
1	2	3	1	Nominal	22.1
1	2	5	1	Nominal	19.8
1	2	7	1	Nominal	18.7
1	2	8	1	Nominal	18.7
1	2	5	3.3	Nominal	24.4
1	2	7	3.3	Nominal	21.5
1	2	9	3.3	Nominal	20.1
1	2	11	3.3	Nominal	19.6
1	2	12	3.3	Nominal	19.6
1	2	5	1	Reduced	20.4
1	2	9	3.3	Reduced	20.8

* Four causeway sections.

Next, the ship-to-shore distance was increased to 3.3 nmi. In this case when the number of LCUs was increased to 11 a minimum time of 19.6 hr was achieved. As in the bare beach operation, increasing the distance required a significant increase in the number of lighters but resulted in only a slight increase in total elapsed time.

The last two runs shown in Table D.6 were repeated using reduced speeds for two lighters, to calculate how many extra lighters would be needed. The speeds of both the LCM8 and LCU were reduced (approximately 2 knots) and the speed of the causeway ferry remained the same. When the ship was located 1 nmi off-shore, the minimum time increased from 18.7 hr to 20.4 hr. At 3.3 nmi, the minimum time increased from 19.6 hr to 20.8 hr. These results indicate that total time to off-load 300 containers is insensitive to the above reduced lighter speeds.

Finally, a special run was made to determine the effect of removing the causeway ferry from the above mix of lighters. As mentioned earlier, at 1 nmi it had required 18.7 hr to discharge the 300 containers with the causeway ferry in the lighter mix. The time increased to 19.1 hr when the causeway ferry was removed from the mix. The following explanation is given for the small increase in time. It requires approximately three times as long to load the causeway ferry at the ship as it takes to load an LCU, because the causeway ferry carries 12 containers and the LCU carries four. While the causeway ferry is being loaded, LCUs returning from the beach wait in the queue at the ship until the causeway is full. When the causeway ferry casts off approximately four LCUs are waiting to be loaded. Similarly, the causeway ferry requires three times as long to off-load at the beach as an LCU. When the causeway ferry casts off from the beach there are four LCUs waiting to be off-loaded. Thus, it can be seen that lighters with large differences in capacities tend to interfere with each other in a LOTS operation.

In summary, for the case of the containership located 1 nmi off-shore, it would require at least one causeway ferry (4 sections), two LCM8s and seven LCUs to discharge 300 containers a day. (Extra lighters should be available for breakdowns and maintenance requirements.) For 3.3 nmi at least one causeway ferry, two LCM8s and 11 LCUs are required.

Truck Requirements

An additional set of runs was made to determine the minimum number of trucks required to transport 300 containers from the beach to a marshalling area located 1.5 miles inland. Truck speed and the number of containers carried on the trailer were varied and the results are shown in Table D.7. In the "best" case at least six trucks and trailers were needed operating at the higher indicated speeds and capacities. Additional vehicles will be required for a reserve operational and maintenance float.

TABLE D.7
NUMBER OF TRUCKS AND TRAILERS REQUIRED
(Marshalling Area 15 Miles Inland)

Truck Speed (mph)		Number of Containers Per Trailer	Trucks and Trailers Required
Empty	Loaded		
10	10	1	10
10	10	2	8
20	15	2	6

Planned Runs

As previously noted, the crane-on-beach was assumed to be operational during a full day. The present concept for the crane-on-beach has it operating mostly during periods close to high tides. This concept will be simulated to determine the effect of the reduced operating time on the total LOTS system. During periods of low tide two cranes on the containership will be loading amphibians. The amphibians will be unloaded by one crane inland. This situation will result in a queue at the inland crane. Also, the effect of locating the amphibian crane close to the beach as opposed to having it in the marshalling area will be calculated. With the amphibian unloading site closer to the beach, the capacity of the amphibians will be increased by reducing the distance they have to travel. However, more trucks will be required.

The improved beach phase employing both the elevated causeway and the "B" DeLong pier will also be simulated. This phase of the test has the potential for the most throughput, since a back-up crane will be used along with the temporary container discharge facility and the crane-on-deck to off-load the containership. This is one more crane than used in the other phases of

the test. It is expected that the greatest stress on transportation resources and the marshalling area will occur during this phase.

The final design for the hatch bridging kit to support a crane on the deck of a containership was selected and fabrication will start in the near future. Data should be available soon to permit better performance estimates to be incorporated in the model. Data requirements include hatch bridging kit and crane locations for discharging the ship, and the number of hatches within the reach of the crane from each location. Also, the time required to move the kit to a new location. Additionally, a different type ship from that used in prior runs may be selected for the test. When these data are available additional runs will be made to determine their impact on test planning.

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